HANDBOOK
of
NATURAL HISTORY

for the use of
Beginners

EDITED BY

THE LADY ISABEL MARGESSON

A HANDBOOK

TO THE STUDY OF

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WITH AN INTRODUCTION BY

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EDITED BY THE LADY ISABEL MARGESSON.

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EDITOR'S NOTE.

In offering this Handbook to lovers of Nature, I wish very heartily to thank all the Contributors who have so kindly enabled me to carry out my idea of putting before the Beginner a clue to the many paths of the somewhat bewildering labyrinth called Natural Science.

I hope the following Chapters may overcome some of the difficulties felt by would-be learners, who are often baffled at the beginning of their studies by their ignorance of the right lines on which to work.

The Book is not intended to take the place of a Primer; it aims, rather, at being indicative of the possibilities and limitations of many branches of the Science, the Author of each Chapter aspiring to play the part of the "Naturalist friend" to the mere lover of Nature, in persuading him to gain some certain knowledge of her laws and secrets. Such a description is here set before the Reader, as will enable him to choose for his studies that particular branch for which he has the most inclination and aptitude.

I must especially offer my sincere thanks to Sir Mountstuart Grant Duff, for his kindness in writing the Introduction to this Book. May I add that Sir Mountstuart is the "Naturalist friend," who, some years ago, persuaded me to take up the study of Botany, for which I shall always owe him a debt of gratitude.

ISABEL A. MARGESSON.

63, *St. George's Road, S. W.*,
May, 1894.

INTRODUCTION.

THIS book is an insidious attack upon that blissful ignorance of the objects immediately surrounding them which has for some time been the apanage, in all countries, of many who imagine themselves to have received 'a first-rate education.' Beyond the pale of civilization it is not unusual to find people whose observing faculties, abnormally cultivated by the necessities of their life, have taught them a great deal about their environment. I remember coming across a set of all but naked barbarians, at Matheran, in the Bombay hills, who knew the name of every tree or shrub in their jungles; and I also remember asking a subordinate of the Forest Department, in another part of India—who would have been very much hurt, indeed, if he had been considered beyond the pale of civilization—the name of a shrub we were passing, and being rewarded by the novel information that it was 'a shrub.' Lady Isabel Margesson has, by collecting and editing these papers, practised against the peace of that large class of persons who desire to know nothing beyond the fact that a shrub is a shrub, and a bird a bird—a class admirably represented by a boy, who, after listening with exemplary patience to some botanical information which was being communicated to him, said, 'Now, Uncle Charles, don't you think we might stop and talk like gentlemen for a little?'

In carrying into effect her nefarious design, Lady Isabel has been abetted by a number of associates who have given many years to the study of various branches

of Natural History. Each of these is responsible for a chapter, and all have entered into her idea, which was to help people who had a desire to know something of the Natural World, but no definite notion as to how they were to begin. Her undertaking was the outcome of an experiment to form a small society, amongst some of her friends, for the purpose of studying Natural History, which seemed likely to succumb, at the outset of its career, to the very difficulty I have indicated—the difficulty of making a first step.

This book, placed in the hands of the members of that association, or of any similar body, will effectually prevent such a catastrophe, for the writers of all the chapters have been most careful to show how students, young or old, can most easily and profitably approach the subjects dealt with in each; how they should observe, what books they should read, with what instruments they should be furnished, and where they can best procure those instruments.

The papers are far too numerous for me to remark upon all separately in a brief prefatory notice; but I may say a word about one or two of them.

Mr. Arthur Thomson, the author of the 'Study of Animal Life,' in Murray's University Extension Series, treats of Zoology. He would have children begin by watching the ebb and flow of the seasons, putting the manuals, necessary to help them in so doing in the hands of their parents. He would discourage in the latter the habit of treating anything with carelessness—the habit of saying 'that's only a leaf,' or 'this is nothing but a shell.' He would have early attention given to the curious action and interaction of plants on plants, animals on animals, and each class upon the other. He would early make his pupils acquainted with the works of the traveller-naturalists. He

would interest them in the every-day life of animals, holding that 'hunger and love solve life's problems.' These studies would lead on to the analysis of structure; this to the activities of the animal body, and that to the history of animal life, and the study of causes. Under every one of these heads he gives copious lists of books, which will make the path he invites those whom he addresses to tread, an easy and a pleasant one.

Botany has been confided to Professor Geddes, who is evidently in thorough sympathy with Mr. Arthur Thomson's ideas, and writes *mutatis mutandis* just in the same vein.

His view is put in a fanciful, but effective, way in some sentences which I extract from his 'Chapters in Modern Botany.'

'To the dawning intelligence of the race, the forest is vaguely astir with a life which man does not clearly separate from his own—a mystery of growth which has left its mark deep in the history of all religions. A later and more self-conscious mind moulds this omnipresent life into anthropomorphic shapes; so a Dryad hides in every tree, while Pan roams through the glade. These anthropomorphic shapes are next formalised away from the living realities they symbolise; they become mere shadowy gods, then fairies and fables.'

* * * * *

'But as the ages of fetishism, of Hellenic anthropomorphism passed away, so now the formal and utilitarian and analytic spirit is passing also in its turn. Science is entering a new and brighter Hellas; the Dryad, living and breathing, moving and sensitive, is again within her tree; nay better, the plant is herself the living Dryad, her naked beauty radiant in the sun.'

The point of Professor Geddes's paper is that plants should be studied as living organisms, 'as moving, feeling, breathing, struggling creatures.' Books are absolutely necessary, and herbaria are no less necessary, but the chief place of learning should be the fields. He accompanies his readers through the seasons, and suggests that each should make for himself a Naturalist's Year-Book. He gives a full list of works calculated to assist in this enterprise, but, lest his pupils should fall into too easy ways, insists, most wisely, upon accuracy and precision. By his method, with the assistance of any good English Flora, such as Hooker's or Bentham's, and a reasonable amount of locomotion, the student will easily obtain a large and accurate knowledge of British plants.

When this has been done, however, there are many new regions to conquer; the whole world's flora lies before the enquirer. Such books as Humboldt's 'Aspects of Nature,' and Darwin's 'Naturalist's Voyage,' and Miss North's collection at Kew, which will, doubtless, soon give birth to similar galleries in other places, will enable even the home-keeping traveller to form many correct ideas.

Hours in the fields, judiciously combined with hours in the library, will lead to questionings about the web of life, and the influence of plants and animals upon each other; to the works of Sir John Lubbock, and so many more who have devoted themselves to this branch of observation. Then will come physiological botany, which has of late years been engrossing the attention of an undue number of workers, but is none the less indispensable to those who would understand the life of the plant.

Time was when the followers of Linnæus had it all their own way, and Systematic botany ruled supreme.

Now a new generation has arisen, and it is even said that people pass for great botanists who have not a speaking acquaintance with many of the commonest plants. From all that, however, there will be a reaction; Systematic and Physiological botany will be seen to be sisters, not rivals.

'We do not suppose,' says Professor Geddes, towards the close of his paper, 'that the thorough student can dispense with any of the disciplines above mentioned; he must still study in the schools of Linnæus, of Jussieu, and of all the great masters, but no longer as a drudge, hoping some day to get to the fields, rather as a field-naturalist, who takes to the laboratory and the library to find the solution of the puzzles which his day's observations have brought him to face.'

This is the true doctrine, and they who follow it will advance far further and faster than those who begin with school text-books, which are too often got up merely for examination purposes, and, far from leading their victims into the pleasant paths of botanical study, teach them in after years to loathe its very name.

Mrs. Tindall, in a chapter on the Study of Mosses, breaks ground by pointing out that the good time of those who collect them begins just as the year is ending for those who devote themselves to flowering plants; enumerates the necessary appliances, tells the student how his specimens should be dried, gives a general description of the tribe and an account of some of its more important divisions, takes a rapid survey of the nearly allied group of the Liver-worts, and indicates alike the manuals that will be most useful to the beginner, and those which will assist in the later stages of study. One warning which she gives is highly important:—

'A very small quantity of each Moss is suffi-

cient for preservation as a herbarium specimen or for investigation; therefore, let not the joy of the collector, in finding a plant hitherto unknown to him, lead him to gather all he sees. Through thoughtlessness in this respect rare plants may be exterminated; the goose is killed that lays the golden eggs.'

This hint is, at least, of as much moment to those who gather flowering plants, and will become of more and more importance as Natural History extends. In Switzerland the havoc which has been wrought by schools, and still more by persons tearing up plants with a view to sell them, has led in some places to legislation, and to the formation of a society, presided over by Mr. H. Correvon, for the purpose of protecting the rarer Alpine plants, which are menaced with destruction by thoughtless or thievish persons. This gentleman has an establishment at Geneva, where Alpine plants, all grown from seed, may be bought, and where, also, their seeds can be obtained. It only requires to be known, I think, to be a great commercial success, provided always the persons in charge of it take care to send really good plants, and not poor specimens—a first condition of success in all such enterprises.

Although no plant in a herbarium is perfect without its roots, the importance of preserving the wild vegetation in a thickly-peopled country is so great, that no schools or ordinary botanical students should ever be allowed to root up plants which are in the slightest degree rare, and the mischievous practice of collecting specimens for exchange should be as much discouraged as possible. If this is not done, sooner or later the owners of the land, on which the rarer plants of the country grow, will become alive to their treasures, and will make it very uncomfortable to carry on herborisation, thereby injuring students and preventing a great

deal of harmless pleasure, by enforcing restrictions, for which, however, collectors will only have to thank their own folly.

Fungi are treated by Miss Lorrain Smith, recommended, like Mrs. Tindall, by Mr. Murray, the head of the Cryptogamic Department in the Natural History Section of the British Museum, who begins by setting forth that there are in this country twice as many fungi as there are flowering plants, and that a successful collector may any day discover a new one. She sketches a number of the groups into which they are divided, tells, a little too briefly for clearness, the curious story of the corn-mildew, which passes the early part of its life on the barberry tree; her object being, I suppose, rather to show that there are very strange and unexpected facts to be discovered in connection with the organisms of which she treats, than to give more definite information; hints the necessity for care even in dealing with the so-called edible fungi, and gives a short list of the works which she recommends.

Shells, Fossils and Seaweeds have all fallen into good hands, as has the Microscope.

A great many useful hints are to be gathered from Miss Hodgson's paper on 'Teaching Natural Science,' the fruit evidently of much experience, and from Miss Carrington's 'How to observe without destroying.'

Even the inorganic world has received some notice in this volume, for there is an excellent chapter upon minerals. Its author recommends the student to begin by familiarising his eye with the various characters of the different rocks, in railway cuttings, among mountains, or sea cliffs. Then he should collect a few specimens of these rocks, and try by, closer examination, to determine the causes which make their appear-

ances to vary. Next, having carefully noted what a mere inspection of his specimens can teach him, he should make such simple experiments upon them as will enable him to determine their more obvious characters—hardness, cleavage, specific gravity, and the like. The student in or near London has the immense advantage of finding, in the Natural History Museum, in Cromwell Road, the most elaborate series of specimens and models illustrating the character of minerals. There is hardly a single important term in the science which is not explained in that collection by the very best specimens that can be obtained, and this with a clearness which the united ability of all the mineralogists who ever lived could not possibly attain through written descriptions. This wonderful ladder to learning is to be found under the windows along the left side of the Mineralogical Gallery, looking from the entrance. I should doubt if there is anywhere a more skilfully planned introduction to any science. It is a masterpiece of good arrangement. When a fairly good knowledge of the appearance of the more important minerals has been obtained, the student who wishes to push far into the subject, will find several diverging roads which will enable him to do so. There is the road of chemistry, by which he will ascertain the composition of his specimens; there is the investigation of the phenomena connected with the transmission of light through transparent minerals, and the use of the instruments, gradually increasing in number, by which a skilled operator can, in a few moments, readily distinguish between precious stones, whose likeness to each other sometimes baffles the keenest and most practised sight.

Only a limited number of those who are introduced by this book to the subject of Mineralogy, will enter the

exceedingly difficult path of Crystallography, but, even without doing this, the student may advance far enough to learn much that will give him the greatest possible pleasure, and not unfrequently, if he chances to travel in little known countries, enable him to find a road to fortune for himself or others. I observe that nothing is said in this paper about the help that may be given to beginners by collections which are to be had at a very moderate price; but they are, undoubtedly, useful, for one of the greatest difficulties, at the threshold of the study of any of the sciences of observation, is the multiplicity of objects upon which the eye falls. All young botanists know that, even if they have the very best books and access to a herbarium, it is a great advantage to have some friend who can tell them, in the fields, the names of a hundred or so of the commonest plants in their neighbourhood. It is just the same with the study of minerals, and a fragment, however small, of quartz, or granite, or schorl, tells much more to an ignorant eye than does a herbarium specimen—almost as much, indeed, as a human guide.

It is probable that only a small percentage of the young people who read this book will ever take to any branch of science as the principal interest of their lives; but, although it is necessary for the progress of the world that the number of those who devote themselves to adding to the stores of science should be greatly multiplied, that must always be the work of the comparatively few. It is, however, hardly less important that the broad undisputed conclusions of science should, in each generation, become part and parcel of the minds of all persons who have a claim to be called educated. It is infinitely desirable that society should be full of men and women who know something of the methods by which truth is won, and

whose own intellects have been trained to work according to those methods. It is hardly less desirable that the conversation of cultivated people should be enriched by its becoming as much saturated with observation as it is often now saturated with books. The whole tendency of school education has been, and, I am afraid, to a great extent still is, to divide all life between a very narrow circle of not very informing studies and boyish games. As long as games are merely games, they are all well enough; but the tendency of the day is to make them pursuits. Forty years ago they ceased with adolescence; now grave and learned persons, at Oxford and elsewhere, are not ashamed to give every encouragement to young men to fool away their time in such things. Meanwhile the observing faculties, those which are the first to develope, become hopelessly atrophied. It is far from unlikely, however, that, good coming out of evil, a considerable impulse may be given to the training of the observing faculties by the heavy loss which has been of late sustained by the landed interest. Many squires will doubtless sell their estates, and embrace other modes of life; but the majority will remain on their ancestral acres, take perforce to cultivating their own land, and to less expensive forms of amusement than those to which their fathers were accustomed. The more intelligent of them will gradually find out that there is a vast deal of pleasure to be got out of a country life without the organization of massacre, and be able to say what the late M. Van de Weyer did to an over-zealous host, who, after providing for a good deal of that kind of thing, turned to him with the enquiry: 'And now, what can I do for you?' 'Oh! thank you very much,' was the old diplomatist's reply, 'I don't want to kill anything not even time.' The spread of democratic feeling, the

diminution of the direct political power of the landlord, and a variety of other changes which are going on in the rural life of England, are all likely to act more or less in the same way.

Literature has, probably, a great deal to gain from a quickening of interest in the material world. Everyone must be conscious of the curious effort in much modern writing to supply the absence of fresh facts and ideas, by saying old things in a new and much more difficult way. For a moment the strange contortions of the writer attract our attention; but it is presently found that his performance is a mere acrobatic feat, proving nothing more than the presence of a certain cleverness. The mind of the reader is neither enriched nor soothed. There is but one remedy, and that is greatly to increase the number of facts with which literature deals; but, however skilfully these facts and thoughts may be presented, the mind of the public must be educated to take them in, if those who present them are to produce any immediate effect. The next age will, I think, be of the opinion that ours has piled up a vast amount of material, alike in poetry and in prose fiction, which has little message for it, and will, I trust, take to working up, for itself and posterity, according to the old rules of literary form, a great many thoughts which were wholly unknown to the generation before our own, and have not produced much effect upon those of our contemporaries who are sufficiently skilled in the manipulation of language to say new things effectively, if they had any new things to say.

Literature will, in her turn, repay with interest all she gains from a larger commerce with Nature. How much, for example, has the singer of *Thyrsis*, and the *Scholar-Gipsy*—the most botanical of all

our English poets—done for not a few of our most familiar plants? The *Colchicum Autumnale* of the Alpine pastures (even although he put it in a wrong order, and called it a Crocus) has obtained a patent of nobility from him, as has the Fritillary of the Oxford meadows, and he has heightened the charms of the Bluebell, the spotted Orchis, the White Anemone, the field Convolvulus, and I know not how many more of our oldest favourites.

M. E. Grant-Duff.

Zoology.

By J. ARTHUR THOMSON,

Author of "The Study of Animal Life," &c.

Zoology.

A CENTURY hence, or less, advice as to the best ways of *beginning* the study of Zoology will, I believe, appear strangely old-fashioned. For the extension of Kinder-Garten and other rational methods of education leads one to hope that in the future the child will pass naturally and almost unconsciously through the portals of the different sciences, and that inquisitive interest in life and things will be allowed to spread in broadening circles, and not restricted to lines or segments. Then for a teacher to say "Let me tell you how to begin the study of natural history" will seem as quaint as it now does to hear a schoolgirl say that she has "finished her education."

But it is not so yet, and that is excuse enough for the following suggestions, of which the most important is this: that one should begin with whatever naturally attracts one, for the letter of logical method is apt to kill the spirit of organic interest which alone gives life to learning. One mind is attracted by the flight of a bird, another by its bleached bones on the heath, a third by the tadpoles in the pond, a

fourth by the fossils in the quarry. It is all the same. To each his own way is best; along any meridian he can go round the world. But of course he must make sure that he *is* going round the world, and not merely going round in a small circle like a traveller in the mist. Hence the use of charts and compass such as this book supplies.*

I.—STUDY OF THE SEASONS.—Could I begin again as a little child, I should do what every child in natural surroundings tends to do—watch the ebb and flow of the seasons. I should begin on the first of April, though it may not seem auspicious, and watch the life of the opening month—the opening of the musical season among the birds, the opening of the prison doors within which so many forms of life have lain in bonds throughout the winter, the opening of the eggs within the nest, the opening of the hearts of many different creatures in joy and love. And in this—Nature's Easter—would the child share, for Whitman was picturing the normal when he wrote: "There was a child, who went forth

* In a little book, *The Study of Animal Life*, I have said my say, for the meantime, as to the ways in which we may study animal life, and as I have there given references to some of the "Best Books," I have refrained in this article, which it has been a real pleasure to write, from over-burdening the text with catalogues.

every day, and everything that child saw became part of him for a day, or part of a day, for years, or for stretching cycles of years."

As spring grows into summer, the child will watch the growing lambs, and chickens, and ducklings, until they lose interest for him in assuming the respectable stolidity of domesticated life. The tadpoles are more interesting, and the quaint young gnats. There are new arrivals of birds from the South, and those who have hungry nestlings to feed are busy all the day. With the brightening flowers too there appear the winged insects—the birds of the backboneless kingdom.

But I cannot even hint at all there is to see in the great drama—from the pageant of summer to the rest and silence of winter, from the southward flight of the birds in autumn, to their return again in spring, a succession of events all beautiful in their time. The child will not wish for books, but his parents will, and the following may be mentioned as likely to be useful—Gilbert White's evergreen *Natural History of Selborne*; Charles Roberts' *Naturalist's Diary;* J. G. and Th. Wood's *Field Naturalist's Handbook*; Grant Allen's *Colin Clout's Calendar;* Richard Jefferies' *Gamekeeper at Home*, etc. There is also a welcome promise of a series of

twelve little books on *The Country Month by Month*, edited by Prof. Boulger and by Mrs. J. A. Owen, who has made us acquainted with the "Son of the Marshes."

II.—Common Objects.—Through laziness, disuse, over-pressure, and for other reasons our senses become blunted to what is common. It requires an elephant to wake us up to the fact of animal life, though an ant is just as interesting and marvellous. We have been "educated" to ignore the commonplace, and we have to work back painfully from the sea-serpent to the earthworm. But to the child, as to the wise, everything is equally wonderful. This is the child's natural attitude, but it is soon lost, when we tell him that "that's only a leaf," and that "this is nothing but a shell," as we infect him with our own carelessness. Rather, as Walt Whitman says, should we feel, "I believe that everything is perfect, the grain of sand and the egg of the wren."

Some books may help us to realise the interest of the commonplace, such as J. G. Wood's *Common Objects of the Sea-shore*, 1857, and *Common Objects of the Country*; the somewhat unequal *Young Collector's Series*, by various authors; Charles Kingsley's *Glaucus*; P. H. Gosse's *Romance of Natural History* and *Tenby*;

and, as a pattern, Darwin's book on Earth-worms.

III.—The Web of Life.—As children, we had, if I remember aright, a casual reflective wonder at the aspect of things suggested by *The House that Jack built;* as naturalists we are ever repeating the same rhyme, with altered words. Such is Darwin's "cats and clover" story.

It is a view of life worth striving after, which the phrase, "web of life," suggests. We are familiar with the idea that the parts of our body are knit together in co-operation, and also related competitively; if one member suffer, others suffer with it. We speak of this fact as the correlation of organs. But we must also make real to ourselves the fact of the correlation of organisms. Gilbert White realised it, and the poets have, as usual, been ahead of the men of science in seeing that all things are inter-related. Not a sparrow falls to the ground without sending a throb through a wide circle.

Of all naturalists, Darwin has realised most perfectly this conception of a "web of life," and from his works, e.g. *The Origin of Species*, we may seek help in finding illustrations. But if this suggested reading be too hard, may I refer you to the chapters on the "web of life,"

in Prof. Geddes' *Modern Botany*, and my *Study of Animal Life*, both in Murray's University Extension Series.

IV.—The World's Fauna.—One of the most fascinating introductions to the study of Zoology is that supplied by the works of the travelling naturalists. To read them is a delight, and, if we can combine their pictures of life, we gain an intellectual treasure worth having. Fancy a Zoo with all the animals in their natural setting and without iron bars; or the National Museum arranged geographically and vitalised. It is obvious that those who have the opportunity of knowing these two institutions can make the pictures of the naturalist travellers very real indeed. But even without these advantages it is possible—scratch the cat and you get a tiger—and even we provincials have Wombwell and Bostock's menagerie!

Among the classic works of the traveller-naturalists are:—Humbolt's *Personal Narrative of Travels in Equatorial America*, Darwin's *Voyage of the Beagle*, Bates' *Naturalist on the Amazons*, Belt's *Naturalist in Nicaragua*, Wallace's *Malay Archipelago*, *Tropical Nature*, &c., Wyville Thomson's *Depths of the Sea*, *Narrative of the Voyage of the Challenger*, and Moseley's

Naturalist on the Challenger. I can think of no pleasanter introduction to Zoology than W. H. Hudson's *Naturalist in La Plata*; if that book awakens no interest in the science, it were better perhaps for the reader to submit to the inevitable. One of the best books of this kind is Brehm's *Vom Nordpol zum Equator*, which will shortly appear (1894) in translation. I hope in editing this translation to be able to insert references to the most important works of the naturalist travellers, for of all the different ways of approaching the study of Zoology, this is perhaps the most human and interesting. For the more precisely scientific discussion of the geographical distribution of animals, Heilprin's excellent volume in the International Scientific Series, and Wallace's *Island Life*, are strongly to be recommended.

V.—The Everyday Life of Animals.—For animals, as for ourselves, life is a continuous endeavour after well-being, partly selfish, partly altruistic, in great part both. One aspect of this endeavour after well-being is the struggle for existence, the other is the expression of love and kinship. On the one hand, we are told that "contention is the vital force," but there is co-operation as well as competition, mutual aid as well as rivalry. The world is

the abode of the strong, but it is also the home of the loving. Hunger *and* love solve life's problems.

You will find it interesting to read the chapters on the struggle for existence in Darwin's *Origin of Species* or in Wallace's *Darwinism*, and then, for the other side, such books as Espinas' *Les Sociétés Animales* and Girod's *Les Sociétés chez les Animaux*. Or to lighten the reading to two articles, contrast Huxley on *The Struggle for Existence* ("Nineteenth Century," 1888) with that of Kropotkin a year later in the same journal on *Mutual Aid among Animals*. Then, with the two aspects clearly before you, or better still, without any preconceptions at all, will you not use what opportunities you have of observing the ways of living creatures, and that not listlessly, but with the definite object of knowing how the heart of nature beats?

If you need books to help you, may I recommend such as Gilbert White's *Natural History of Selborne;* Richard Jefferies' *Gamekeeper at Home, Wild Life in a Southern County, The Open Air, Nature near London*, etc.; John Burroughs' *Birds and Poets, Locusts and Wild Honey*, etc.; Thoreau's *Walden;* Charles Kingsley's *Water Babies;* Hamerton's *Chap-*

ters on Animals; Lloyd Morgan's *Animal Sketches;* Knight's *Idylls of the Field* and *By Leafy Ways;* Butler's *Insects of the Household;* and Hudson's *Birds of a Parish;* Charles St. John's *Wild Sports* and *Natural History of the Highlands;* Houssay's *Industries of Animals;* J. G. Wood's *Homes without Hands;* Frédericq's *La Lutte pour l'existence chez les Animaux Marins;* and one or two of the works of "A Son of the Marshes," edited by Mrs. J. A. Owen. Among large books of reference not too technical to be mentioned here, three may be mentioned—Cassell's *Natural History* (6 vols.); *The Standard, or Riverside Natural History* (6 vols.); Brehm's *Thierleben* (10 vols.) *The Royal Natural History*, just begun under Mr. Lydekker's editorship, promises to be a splendid work.

VI.—The Study of Structure.—It is no doubt pleasanter to watch the flight of a bird, than to dissect its muscles, but in due season there must be an analysis of structure. Nor need one kill much in order to see; the Zoologist must do so, but for others nature herself affords sufficient opportunities of studying the dead. There is work for a week on the sea-shore after a storm.

One naturally begins with the outside,

relating the features of the animal—the boat-like build of a duck, the wedge-shape of a fish—to the conditions of its life. But one must take the engine to pieces, to see the boilers and the pistons, and the wheels within wheels. The mere unravelling of the structure—say of a snail—becomes as an exercise of dexterity, a pleasure, apart from the intellectual satisfaction of the analysis. Even the dry bones acquire a living interest, as we follow, for instance, the various transformations of the fore-limb in fish and frog, bird and bat, whale and horse. And as we begin to have a distinct picture and understanding of the larger parts, we naturally penetrate more deeply, using the microscope to discover the various strands or tissues, the minute units or cells, and the living matter itself.

I know of no better general introduction than Miss Arabella Buckley's *Life and her Children* and *Winners in Life's Race.* For comparative work an excellent guide is Prof. Jeffrey Bell's *Comparative Anatomy and Physiology,* and there are numerous good practical books which will help the student if he do not make crutches of them.

There is much to be said in favour of the method which leads the student to work patiently at one animal until he can see it

through and through, until he has "a transparent mind-model" of its structure. The most successful book on this method is Prof. Huxley's *Crayfish*, but there are many others, such as the late Prof. Milnes Marshall's *Frog*, Cheshire's *Bee*, Miall and Denny's *Cockroach*, which deal with types pleasant enough to handle. Sir W. H. Flower's *Horse*, Prof. St. George Mivart's *Cat*, and the like are perhaps more pleasant to read than to verify.

VII.—The Activities of the Animal Body. But it is not enough to take the engine to pieces, we must know how it works, and this is more difficult. We should begin, of course, with observing the animal's life and habits, studying it as an intact unity before we proceed with our analysis. Sooner or later, however, if we are to understand these habits, we must pierce beneath the surface to the inner life of the body.

We may begin for instance by watching the flight of birds, an appropriate subject, if the student of science be the modern augur. We distinguish gliding, sailing, and ordinary flight, the soaring of the lark, and the hovering of the kestrel; we try to catch the forward, downward, backward, upward sweep of the wings on slowly flying birds; we seek help with our problem

from such books as Marey's *Vol des Oiseaux*. Having made sure of what we know and do not know, we may work in two directions—upwards, into "higher physiology," till we face such problems as that of migration, or downwards, into individual physiology till we are baffled by such problems as the contraction of muscle (see Prof. McKendrick's *Life in Motion*).

This study of individual physiology leads us to recognise that there are two master-activities in the body—those of muscular and of nervous parts. The movements are immediately due tc the contractions of muscles, but these are ruled by nervous processes in which the bird becomes aware of outside things and regulates its conduct in relation thereto. But the activities of muscle and nerve imply loss of energy and fatigue, and this leads us to consider how the food is made soluble and diffusible, how it is swept to the hungry tissues by the blood, how oxygen also is carried by the blood to keep the fire of life burning, how carbonic acid gas and other waste products—the ashes of the vital combustion—are swept away, and so on. In such study there is no better guide than Huxley's *Elementary Lessons in Physiology*.

Gradually we must pass from considering the bird as an intact unity like one of ourselves, to

see it as a marvellous living engine, with many parts or organs, as a great web of tissues, as a vast city of cells—competing and co-operating, and finally as an ensouled whirlpool of living matter, which, though ever changing as streams of matter and energy pass in and out, yet retains its integrity till death comes.

I say "ensouled," for after our deepest analysis we have to remember that the animal acts as a unity, that it is a creature with more or less clear consciousness, with some sort of "will," with varying degrees of intelligence and instinct. This is, perhaps, at once the most difficult and the most interesting side of zoology, that of thinking ourselves into the mental or psychical life of animals.

Here one needs all the help that one can get and more besides. Lloyd Morgan's *Animal Life and Intelligence*, and his work on Comparative Psychology in the Contemporary Science Series, may be placed in the first rank along with Romanes' *Animal Intelligence* and *Mental Evolution in Animals*.

VIII.—The History of Animal Life.—There are three ways in which we can study the history of animal life,—(*a*) from the tombs (for the fossil-containing rocks are indeed, 'the strange graveyards of the buried past'), (*b*)

from the cradle (for, in some measure, every creature has "to climb up its own genealogical tree"), and (*c*) from the structure and habits of adult animals, for it is strangely true that the past lives in the present.

As Mr. Bather has written an introduction to the study of fossils, I refer you to his chapter. I should be inclined to begin with such books as Hutchinson's *Extinct Monsters*, which is vivid alike in words and pictures, or Lydekker's *Phases of Animal Life*, or Dawson's *Story of the Earth and Man* (though it is a little out of date). Carus Sterne's (Ernst Krause's) *Werden und Vergehen* is a well-told story of the gradual "Becoming and Disappearing" of the races of animals, and Gaudry's *Les Ancêtres de nos Animaux* is another pleasant introduction to larger works.

There is a lack of a simple introduction to the study of the life-histories of animals, but it is easy enough to make one for oneself. We can watch the development of the gnats and pond-snails, of the silk-moth and the frog, seeking help from such books as Lubbock's *Origin and Transformation of Insects*, St. George Mivart's *Frog*, and the relevant parts of larger books, some of which are noted in my *Study of Animal Life*.

As you come to know more about the structure and habits of animals you will see how impossible it is to understand the present without the past. As with our own institutions and customs, language and clothes, "everything is an antiquity." The teeth of young whalebone whales, the little gill-clefts on the sides of the neck in the embryos of reptile, bird, and mammal and the like, are only intelligible as vestiges of a distant past. Like the unsounded letters in such words as 'leopard' and 'alms,' they give us hints of history. Our own body is a museum of relics.

IX.—The Study of Causes.—Sooner or later we find that none of the schools yet mentioned—of the anatomists, physiologists, or embryologists—can satisfy us. Analysis is not enough, we would know how things have come to be as they are. A merely descriptive history of animal life leaves us unsatisfied—we seek a philosophy of history.

No one would dream of forcing such an enquiry on a young mind, for, though the germs of theorising are, like those of 'wisdom teeth,' of very early origin, they are usually long of sprouting. And it is perhaps well, for the enquiry once begun is never ended. Even Darwin telling of a holiday, speaks longingly of the

child's mood, in which one watches and enjoys the growth of flowers and the flight of birds without vexing oneself with questionings as to how things became thus or thus.

At the same time, I think that Professor Geddes is surely right (see his article on the Study of Flowers) in insisting that the student who leaves the door of Darwin's school unknocked at, because he is constrained by precept or example first to pass through the hard discipline of the analytic schools, is doing needless penance. It is the old mistake of an education which advances along segments instead of spreading in circles. With not one of the disciplines can we safely dispense, but it is in Darwin's school that we get the inspiration and the enlightening which makes the drudgery of analysis a discipline, which makes all the difference between "Necrology," and Biology. Moreover, the education of the citizen is one thing, and that of the zoologist another.

No one now believes that animal life has always been as we see it to-day. Before the fauna of the geological present there was a simpler fauna of the geological yesterday, and before that a simpler fauna still, and so on, back to the mist of life's beginning. We have extended our conception of human history to

the organic world, and believe that the present is in all things the child of the past and the parent of the future. This is "the doctrine of descent," the general idea of evolution.

The evidences in support of this doctrine have been often stated; see, for instance, Darwins *Origin of Species*, and Wallace's *Darwinism*, or, for simpler statement, Clodd's *Story of Creation*, and Grant Allen's *Charles Darwin*.

But we wish to know more. We may be convinced that the present fauna has arisen from simpler types, and that the potentiality of all lay originally in very simple units of living matter. The belief fills us with wonder, but with no mistrust, for we think no less of the oak tree or of the eagle though we know that the life of each began in a minute and apparently simple egg-cell. If we believe with Aristotle and the philosophers that there is nothing in the end which was not also in the beginning, we cannot think meanly of any of our ancestors. The eagle might as well despise the egg.

But how has this progress been effected? How do changes arise; how are some buds on the tree of life pruned off and others left to blossom? These, as you know, are the questions which are so eagerly debated in Darwin's

school, at times so keenly that the inquirer is apt to turn away disappointed with the hot conflict of opinions and the lack of certainty. The theory of evolution is still being evolved, new variations are ever cropping up, and there is the same process of elimination at work in the school as in the course of Nature itself.

Such books as Wallace's *Darwinism*, Romanes' *Darwin and after Darwin*, and Weismann's *Germ-Plasm* will introduce the student to the present aspect of the theory of evolution, while the monthly journal, *Natural Science*, will help him to keep in touch with the progress of discussion. In my *Study of Animal Life* I have tried to present a balance-sheet of opinion, and have given references to some of the most important books on evolution.

One simple idea I may be allowed to state in conclusion. In *Water Babies*—the first book about Natural History which a child should read—Charles Kingsley tells how the boy called Tom got very close to Mother Carey or Dame Nature, of whom he had many questions to ask. He expected to find her very busy making this and mending that, but he found an old lady sitting with her hands folded. When Tom wondered much at this, the Mother said, "You see I make things make themselves."

Birds.

By W. WARDE FOWLER, M.A.,

Author of "A Year with the Birds."

Birds.

"HOW am I to begin to learn to know the birds?" This is a question often asked, and not easily answered. Many boys and girls answer it for themselves, by a kind of instinct. All that I can do here is to give a few hints for setting to work in a sensible way, so that the beginner shall not only learn to identify different species, but also learn how to study their habits, their movements, their language, their changes of plumage, and their nests and eggs. It is the study of these habits that makes ornithology so delightful a pursuit; it can be carried on at all times of the year, and wherever we happen to be, and there is so much still to learn, that no one need ever despair of finding out something about birds that has never been really discovered before. If you only make a good beginning, you will soon be drawn on, and insensibly learn more and more; and you will find that as long as you live you will never exhaust the subject, even if you are confined to one neighbourhood only.

There are three things that you should have to start with:—First, a good pair of eyes, or failing these, a light field-glass; secondly, a note-book, or roomy diary; thirdly, a good handbook of British birds. It is much better to start at once with a really good book, even if it has no coloured illustrations, for pictures are very often misleading, and, as a rule, only give you the male bird in full summer dress, so that after all you are left in the dark as to the females and the young. By far the best handbook is Mr. Howard Saunders' "Manual of British Birds;" or, if that be too expensive, I would strongly recommend an old but excellent book, "British Birds in their Haunts," by the Rev. C. A. Johns. I will also mention Colonel Irby's "Key List of British Birds," which only costs half-a-crown, and Mr. Harting's "Our Summer Migrants," which can be had quite cheap. Of larger works, if they happen to be within your reach, the best are the last edition of Yarrell, and Mr. Seebohm's "British Birds."

Provided with these three things, let us suppose that you are setting to work in the beginning of the year. At that time, if you live in the country, there will probably be birds coming to the window for crumbs; and if the weather is hard, there will be one or two Thrushes and

Blackbirds among the greedy Sparrows. You will probably know these birds already, and will not need to identify them; but look at them carefully, and compare them closely. They belong to the same group of birds, but are very different in colour. What have they in common, that they should be classed together? This is a question that you should set yourself to answer; and another is, What near relations have they in England? In January you will have all the common species of this great family close around you in the country—Blackbird, Song-thrush, Missel-thrush, Fieldfare, and Redwing; all these you must make quite clear about, and, in order to fix what you learn in your memory, you should set apart a page of your note-book for each, and put down there all that you learn about them from your own observation. Notice what they eat, how they fly, what sounds they make, and, as far as you can, try to discover what these sounds mean. As the spring comes on, the Fieldfares and Redwings will begin to disappear, and you must record the dates of their disappearance, taking great care that you are not deceived about it. Before these depart, learn something from your books about the journey they are starting on, and the countries they are going to, and also

about their nests and eggs, even though you may never have a chance of finding them. Now, too, the other three species will have begun to sing, to build nests, to lay eggs, and to bring up young; and here again will be plenty of use for your eyes and ears, as well as your note-book. You must listen to the songs carefully, even if you think you know them quite well; and when the nests are built, you can observe their position, the materials out of which they are made, the colour and size of the eggs, and the appearance of the young birds. Later on again, if you live in a favourable place, you may make some acquaintance with one more member of this family, the Ring-ouzel.

I do not mean, of course, that you should all this time be keeping to one group of birds, and to that only. What I do mean is that it is better to get to know what you can of one group, or of two, or possibly three groups, while you are about it, because in that way you will learn better how to fix the characteristics of different birds in your memory; and when you know one or two groups well you will be able to go on to others—more difficult ones, perhaps—with a surer footing. You might, for example, take in the winter the Thrushes and the Titmice (*Turdidæ* and *Paridæ*), and in the

spring the Swallow kind (*Hirundinidæ*) and the Warblers (*Sylviinæ*); but when you come to these last you will find them very hard to learn, and you will feel the benefit of having had some previous experience in trying to make out the birds of other and simpler groups.

And, in fact, do what you will, you will get puzzled often enough, and of course you will make many blunders. But puzzles are pleasant employment, and mistakes will do no harm if they do but lead you steadily to more accurate habits. In May and June the number of our birds is so great, that you cannot expect to find out what they all are in a single season, much less to learn anything really about their ways. From the middle of March to the middle of May many different kinds of birds will be arriving in England from the South; and some of these you must try to learn to know, in order to be able to record the dates of their arrival in future years. I may give you one or two bits of advice that may be useful in this confusing time; they are based on my own experience during the many years in which I was trying, often without success, to identify the many birds I met with, most of which I now know to be quite common ones.

First:—Get help from anyone who knows

the birds better than you do yourself, but do not rely on such help too much, nor on the books you may have. Trust to yourself to puzzle things out with patience and perseverance; work slowly but surely.

Secondly:—Stick to one bird until you have made quite sure of him. If the leaves are out on the trees you may have to wait a long time, or even some days, before you can get a really good look at him; but, meanwhile, you must mark his song carefully, and when at last he lets you see him, even if you cannot yet be sure of his name, you will by that time know a good deal about the bird. You will come by his name in time, and I must tell you that the bird himself is more important than his name.

Thirdly:—When you have succeeded in identifying a new bird, always find out from your book what other birds belong to the same group, so that you may look out for them and recognize them more easily when the chance comes. For example, when you have made sure of a Wagtail, read about the other species of Wagtails, and learn something of their haunts and habits.

Fourthly:—When you find a nest without seeing the bird to which it belongs, do not touch it, but wait and watch. When you have

seen the bird, if you collect eggs, you will be justified in taking an egg, but not before. This will not only keep you from treating nests carelessly, but will help you to acquire a habit of observation.

And, lastly I may add that although, as I said, a bird is more important than his name, you will in due time find it both convenient and necessary to know not only the English names of the birds you find, but also their Latin or scientific names. There is, unluckily, still much confusion and variation in these names; but if you write at the top of every page of your note-book which is set apart for a bird the Latin name given in any one of the books I mentioned, you will find your trouble will be repaid. The first Latin name of any bird will help you to remember the group to which it belongs, and the second will suggest a particular species in that group. But in this matter of names, and in many others, too, you will soon *learn how to learn*, if you can once make a good beginning.

Shells.

By E. R. SYKES, B.A., F.Z.S.

On Shells.

MANY persons are hindered from the pursuit of Natural History by the difficulty they feel in discovering where to search for the objects they desire, and how, intelligently, they may set about the study of them when found. It is with a view of rendering some assistance in conquering these difficulties, so far as they relate to the study of shells, or, to speak more scientifically and accurately, the mollusca, that this chapter is written. The shell of the animal is but the bare skeleton, and bears in many respects the same relation to the animal as the human skeleton does to the man. Thus it is of greater importance that we should be acquainted with the animal which forms the shell, rather than only with this skeleton. Whole families, indeed, of the mollusca possess no shell at all; a very familiar instance of this we may notice in some kinds of slugs. The sea-slugs (*Nudibranchiata*) possess a very small shell, of the shape of a snail-shell, when they make their first entrance from the egg into the world, but as they grow they cast this off, and

when mature no sign of its ever having existed can be discovered. One great and important feature by which the mollusca (except the bivalves, such as the mussels) may be generally distinguished is in their possession of what is technically called a *radula*; this is a long strap-like organ, furnished with many parallel rows of teeth, sometimes numbering several thousand teeth in a single specimen, and it has furnished much assistance in the subdivision of the families.

I shall first give a few suggestions as to where to look for land, freshwater, and marine mollusca, and shall then call attention to one or two of the more striking species found in Britain.

Land Shells, it must be remembered, are in general fond of moist situations, and like shady places where they can retire from the hot sun; many species also hibernate in winter, and may be then found in large clusters, sometimes fifty or sixty together, under stones. Search your garden, and then go out and search in the hedgerows; examine carefully the weeds, and especially the nettles, of which they are very fond. Never pass a stone of any size lying in the grass without turning it over, unless it is very tightly embedded, and the same may

be said of branches of trees, old logs, etc. Snails are also fond of getting under the bark and into the ends of old tree-trunks, and in the spring and autumn some species (especially the *Clausiliae,* of which more anon) like climbing trees, and may be seen several feet up clinging to the bark. Some of the smaller species are found under old and fallen leaves, and anyone who will be troubled to take a bag-ful of these home and dry them, often, after shaking them, reaps a rich harvest. Remember that a chalky soil is the best of all for finding land-shells; they do not like pine woods. Almost any time of year will do to search in, except when there is a frost, and in the summer, when the ground is very dry, little may be found, though a shower will bring them out in such multitudes that country people often think they have fallen from the skies.

Freshwater Shells are to be found in every pond, stream, and river in the country. They may even be found in the mud at the bottom of a horse-trough. Lift out gently some of the growing weed on to the bank and turn it over; there, adhering to it, you will see the shells. Get a small dredge on the end of a stick, like a dwarfed butterfly-net, and scoop out some of the mud from the bottom; let the mud filter

away, and you will find mollusca, bivalve and univalve, amongst the twigs, stones, etc. Do not plunge the dredge deeply into the mud, but drag it over the surface, so that it is only buried from a quarter to half an inch.

For Sea Shells, which are more attractive to most people than others, from their greater beauty of colouring, every portion of the shore, from the tide-marks down to the greatest depth you can attain, should be searched. Always, when collecting on the shore, go as low down towards the tide as you can; low water is, of course, the best time. Turn over the stones and examine them carefully, also search all growing weed. Some species live in the hollows of the rock, and are provided with the means of excavating holes for themselves. Even at the present day, naturalists are not entirely agreed how this is done, some suggesting that it is by a rotatory scraping of the shell, others by the secretion of an acid, and others by the rubbing of the foot of the animal. The writer is a believer in the latter theory. It may be found useful, when collecting small species, to take a handful of weeds home and wash it in water. If it is desired to kill the specimens, fresh water will cause them to drop off instantly. The shells along the tide-mark, though dead,

should be gathered. The way above all others of obtaining marine mollusca, however, is by the dredge, worked from a rowing or sailing boat. Remember always to work with and not against the tide. The extraordinary fascination of this work cannot be realised by anyone who has not tried it. Down goes the dredge, attached to a rope from two to three times as long as the depth of water, and you wait and drift. At last it comes up slowly through the water, and all eyes watch it on its way; the contents are turned out into the bottom of the boat and down you stoop. It may be that very little will reward you, it may be that you will see such an assemblage of marine life as never falls to those who stay on shore. A special 'Naturalist's Dredge' is made by Hearder and Son, Union Street, Plymouth; the mesh of all these nets is, however, rather wide for the very minute species, and it is advisable to line the last six or eight inches of the bag with 'cheese bag,' or some such fine material. Do not get too wide a mouthed dredge, or it will be too cumbersome for a small boat; about eighteen inches is wide enough. Some species live buried in the sand, and these should be sought for at low tide; a common spoon is often enough, but a few will require a spade to obtain them.

There is, indeed, hardly a spot on this globe that will not yield something to the observant naturalist. Remember, however, that a trained and practised eye will discover much where a beginner will find but little, and be not discouraged if, after a day's hard work, you have not a very large result to show. Patience and perseverance must be your motto, in shell-collecting as in nearly everything else.

The bare collecting, however, should not be the end of your aspirations; you should endeavour to arrive not only at the possession of the shell, but also at a knowledge of the animal which forms it. Try and keep them alive; watch their habits and trace their history from the embryo and egg-stage until full grown. Land shells should be kept under a bell-glass, or in some such form of vivarium, and provided with a box of earth, which should be kept damp; nearly all of them feed very readily on lettuce, and the English carnivorous ones are small and unimportant. Freshwater shells will live with any other freshwater animals, and, if the water is properly aerated, will remain healthy for years. Most marine mollusca can be kept alive in an aquarium; some, however, such as the whelk, are highly carnivorous, and, as they will do a great deal of damage in a

short time, should be kept separate. The marine mollusca are by far the most difficult to keep alive, but, on the other hand, they repay keeping better on account of their greater diversity of structure.

Much information is wanted as to the habits of shells. How is it that a newly dug pond becomes, in a very short time, peopled with an abundance of molluscan life? Where do they come from? How do they get there? Birds and beetles have been captured with snails attached to their feet and legs, and this explanation is the more generally accepted at present to account for their sudden appearance. Whirlwinds, too, have been seen to suddenly rain down shells in company with other animals. Why should one species prefer sandy downs by the sea-shore, while another loves chalky hills? What, again, is the instinct which leads some species, when dredged from abysmal depths of the sea, to crawl to the surface of the water when captured and placed in a jar? Such a habit can never have been formed where they lived. These are only samples of the many questions still awaiting solution, and towards which everyone can lend a helping hand.

It must be remembered that, though here attention is given to recent shells only, the

fossil mollusca must be studied as well. The recent are only the final fauna left us, while the fossil represent the multitudes which have lived and died during the numberless ages in the earth's history. The cuttle-fishes (*Cephalopoda*), though to the uninitiated they would hardly appear to be shells, are yet true mollusca. Some select a hollow under a big stone, and there they lie, stretching out their arms, provided with suckers, to drag in any stray piece of food which may come within reach. Nothing is too small for them, and their lurking places may be known by the large piles of empty shells whose inhabitants they have devoured. They are especially abundant at Herm, in the Channel Islands; and many a collector has to thank the *Octopus* for some of his finest specimens. To this order belong the well-known Pearly Nautilus, the fossil *Ammonites*, and others.

The gorgeously coloured sea-slugs (*Nudibranchiata*) derive their name from their breathing apparatus being placed externally on their backs. A few may be found on the sea-shore, but most of them are only procurable by dredging. Ordinary collectors have paid much less attention to them than they deserve, owing to the fact that they lose a great portion of their colour and beauty in spirits. There is a

small but beautiful set of glass models of them in the Natural History Museum.

A very curious order of marine mollusca is that of the Chitons (*Polyplacophora*); the shell of these curious beings is formed of eight overlapping plates. They may be found under stones on the sea-shore, and were for a long time classed with the limpets, owing to their breathing apparatus being arranged in a somewhat similar manner. If you take one and separate these shell-plates, you will see that they are notched (in most cases) where they enter the animal. It is on the number and arrangement of these notches that the present classification of the group is based. The deep water species are found, in general, to have fewer notches, and smaller portions inserted into the animal, than those which dwell on the shore; this is supposed to be due to the fact that those on the shore are subject to far greater strains, such as the beating of the surf, etc., and so require more support.

At first sight one would hardly believe that most slugs possessed a shell, yet it is so; and though some of them lack it, and in others it has degenerated into a simple shelly plate, still it is generally there. This shelly plate is so placed under the mantle of the animal as to shield the

vital organs. It is sometimes only represented by a few chalky granules. Other slugs again (*Testacella*) possess a small shell, which is placed upon the tail, so a regular graduation may be noticed from those which are absolutely without a vestige of shell, up to the ordinary snails of our gardens, whose shell is large enough to entirely cover them. Some univalve mollusca possess a shelly or horny plate (*operculum*), which is attached to the foot of the animal, and with which he is enabled to close the mouth of his shell against his enemies. A protection of this description is also afforded by the numerous teeth or prominences which encircle the interior surface of the mouth of *Pupa* and other genera. The *operculum* has been used to distinguish families, though it is of no service in discriminating closely allied species; it has been thought by some to replace in the univalves the second valve of the bivalves. It is found both in land, freshwater, and marine shells. In most species, where present, it is highly developed, and is of sufficient size to entirely close the mouth of the shell; but a gradual series may be traced in which it degenerates in size, until at last it is so small that one wonders of what service it can be.

A structure of a similar nature, in so far as it

is a protection to the animal, is the small plate or *Clausilium* (a little door), which is found in almost all species of *Clausilia*. The *Clausiliae* are brownish slender shells, which are found on tree trunks, under logs and stones, and on old walls. The most striking characteristic, at first sight, of those found in this country, is the fact that the twist of the shell is reversed ; that is, if you hold the shell with the mouth facing you it will be on the left-hand side, and not, as is more common, on the right. The peculiarity of the *Clausilium* lies in the fact that it is not attached to the animal but to the shell, and in this, it will be seen, it differs from an *operculum*. The animal, when it protrudes its head from the shell, pushes back this plate, and when it retires the plate is drawn back by the horny attachment joining it to the pillar of the shell, and partially, or wholly, closes the aperture. To see this plate, the mouth of the shell should be broken back about half a turn, and then the *Clausilium* will be seen lying between two of the folds, which, in these species, run back from the mouth sometimes as much as a whole turn or whorl.

One of our minute snails (*Caecilianella acicula*) is noteworthy from being both carnivorous and a dweller in a subterranean habitat.

They are very rarely seen above ground in a living state. A curious fact is that they are entirely eyeless, and resemble in this respect a family which inhabit the subterranean caves of Adelsberg, in Carniola.

I have said nothing of the Lamp-shells (*Terebratula*, etc.), since they have now been found not to be true mollusca, though they are still frequently included in the text books. Though very abundant in a fossil state, they are still uncommon in a living condition.

Whole chapters might be written on the anatomy of the mollusca. This should be carefully studied, and not—as is too frequent—the shell alone. In this work, a day's practical labour will impart more knowledge than can be learnt from text-books in a year. No really thorough knowledge of the mollusca and their classification, can be arrived at without an acquaintance with the animal; remember that it is the inhabitant which forms the shell, and not the shell which forms the inhabitant.

Avoid oiling or varnishing your shells; such practices are all very well for ornamental work, but for your collection you need the shells as they lived. Dirt and weed growing on the shell should, of course, be removed. It is often advisable, in delicate and fragile sea-shells, to

soak them for a few hours in fresh water, otherwise the salt left on may set up chemical action, and spoil their appearance. The *operculum* should be carefully preserved, gummed on a bit of cotton-wool, and placed in the mouth of the shell in the position it occupied when the animal was alive. The very small shells are best kept in glass tubes, and the larger ones in cardboard trays. Always label your shells at once with the locality from which they came; the names can be added afterwards. If labelling is postponed, confusion will often arise, and some very unsatisfactory guessing will take place. All species should be carefully kept separate, and never allowed to become mixed. Do not be in too great a hurry to get a cabinet; some shallow trays with match boxes in them will do very well at first. You need but little preparation to start out collecting; a few wide-mouthed bottles and pill-boxes will be amply sufficient.

The British marine mollusca number about 550, and the land and freshwater about 120; a fairly good collection should contain about 80 per cent. of the former, and 90 per cent. of the latter.

When you have acquired some familiarity with the British shells, you might find it useful

to join the Malacological Society of London which devotes its energies solely to the study of mollusca. Any further information regarding this, or other matters not dealt with in the above brief chapter, the writer will be pleased to endeavour to supply. He may be addressed at 13, Doughty Street, London, W.C.

The following very short selection of books, contains those which the writer has personally found most serviceable; there are, of course, numerous others of the same class.

BOOKS RECOMMENDED.

Wood, Rev. J. G. "Common Shells of the Sea-shore," price 1s. Plain plates and elementary.

Tait, R. "Land and Freshwater Mollusks of Britain," 1866, price 6s. Eleven plates, coloured; deals also with anatomy.

Adams, Lionel E. "Manual of British Land and Freshwater Shells," 1884, price 7s. 6d.

Jeffreys, J. G. "British Conchology," 1862-9. In five volumes, with many plates; a standard work; price about £4 4s.

Sowerby, G. B. "Illustrated Index of British Shells," 1892, price 30s. net. Contains coloured figures of all species but no text; the names are also somewhat out of date.

Fischer, Dr. P. "Manuel de Conchyliologie," price 35 francs. This, though of little use to the beginner, is indispensable to the more advanced student.

The Study of Flowers.

By PROFESSOR PATRICK GEDDES,

Author of "Chapters in Modern Botany," &c.

The Study of Flowers.

FLOWERING plants touch human life at many points. They satisfy many of our material wants, they educate and delight our senses, they are rich in symbolic meanings, some of which take us back to the days when all the world was young. But what we have to do with here is that in the study of flowering plants we find at once the easiest and the pleasantest path towards an understanding of what life means. The "flower in the crannied wall" holds the secret of what God and man is.

Yet all depends on how we study. If we begin with books instead of with the flowers, we shall be repelled and discouraged by the technicalities of traditional pedantry, and we shall forego all the profit—not to speak of the pleasure—of discovering the facts for ourselves. The devotee of the text-book is often the dullard of the fields. Nor will it serve merely to pull countless flowers to pieces, if we gain no vivid picture of the plant as a living organism—a moving, feeling, feeding, breathing, struggling creature—if our Biology be really

only a Necrology. Nor will gathering a huge herbarium serve us, if it be but a carefully interleaved haystack, if it be not the record of our attempts to unravel the complicated pedigrees of plants and to understand their position in the web of life.

Let me suggest certain lines of study which appear to me to be natural, and likely to lead to an understanding — a realisation—of the nature of flowers.

I.—The Seasons.—Every year, in field and garden, wood and hedgerow, nature's drama is played before us—all too dull spectators. First let it be ours to enjoy it, to share in the hopefulness of spring, the gladness of summer, the sober joy of autumn, the repose of winter. That this emotional sympathy with nature is often killed by false methods of scientific education is too true, and has led to that contempt of science which poet and artist often express. But it need not be so. If our acquaintance with nature be allowed to grow naturally, suffering no violence, our emotional sympathy must be proportionally deepened.

If this is to be so we must watch the drama with active interest, allowing no book of the play to divert our attention from the play itself, forming our opinions from what we see

and not from what some commentary tells us, appreciating the general dramatic movement before we become involved in the detailed analysis of any one character. Surely nature's drama deserves to be treated as fairly—as rationally—as any creation of the dramatist.

Thus, as it seems to us, the study of Botany is begun at once most naturally and most profitably by a study of the seasonal progress. Let us then begin when the naturalist's year begins—in Spring; let us study the seeds awakening from their winter sleep, the seedlings raising their heads from the moist ground, the ascent of sap in every herb and tree, the unpacking of the buds, the opening of the early flowers. Observe, think, observe again, and when you are thoroughly puzzled, consult your books. This will take a long time, you say; were it not better to take Botany *en bloc* from a book, and verify afterwards? The choice is between education and mis-education, between intellectual manliness and book bondage. Will you keep to the dictionary and grammar of the science, or will you "see the tide of life set in with a flood in spring, filling every corner of the earth with sprouting seeds and shooting stems, and crowding, spreading, rippling leaves; how as the russet underwood warms to the

fuller sun through trees still bare, it glows with bright golden patches of lesser celandine; how its dead leaves silently sink under a restless foam-tipped sea of green anemone; how every mossy bank is set with primroses in crowded constellation; and how the deep summer sky shows first in sheets of hyacinth."

Soon the summer comes, and with it new scenes, new problems. The full tide of foliage sets in and the colours of the flowers deepen. Whence this colour and what is its meaning? Are the pigments the waste of the plant's vigorous life, the ashes of these flaming fires which we call flowers? Are the bright petals flags which attract the bees and other insects to the feasts of honey? Select some flowers for careful watching, be a child again and follow the bee from blossom to blossom, realise the marvellous interactions between the plants and their visitors. Try to think out the every-day life of the plant, how the roots suck up water and salts from the soil, how the leaves absorb air, how the sunlight shines in upon the living matter of the leaf through a screen of green pigment, how light and life in the leaf's laboratory unite their powers to mingle air and water and salts in subtle secret ways so that the dead becomes part and parcel of the living.

Already the tide has turned, and the flowers are withering and fading. The third act has begun. The insects and the breezes have filled their rôle in carrying the fertilising golden dust from flower to flower. In the heart of each, new lives are born. The seeds are being made. Whence came they, how are they nurtured? The feasts of honey are over, the marriage-robes, of which Ruskin speaks in his beautiful description of the flower (see *Fors Clavigera*) are laid aside, it is the time of bearing fruit. That many of these are sweet we all know, but have we noticed that the nectaries, by which the surplus sugars a short time ago overflowed, are now closed, and that this helps to account for the sweet sap being drafted to swell the succulent fruit. Have we watched the part the birds now play in the drama, devouring the sweet fruits and sowing the undigested seeds, rifling the pods and capsules and losing half the spoil in their eagerness? Do we know who scatters the acorns?

Next year's buds have been formed, the seeds have been scattered in a hundred different ways, the leaves are surrendering the last results of their industry to the parent trees, and the birds are gathering for their southward flight before the cold breath of approaching winter. It is

now the fourth and last act. Winter's spell begins to be felt; life ebbs out of sight. "Proserpina is in Hades; sky and mother earth must mourn till her release."

Your studies will gain in precision if you make for yourselves a naturalist's year book, noting the events of each week—a "Colin Clout's Calender" in fact (see Grant Allen's book with this title). If you need it seek help from the *Naturalist's Diary*, by Roberts, and the *Field Naturalist's Handbook*, by J. G. and Th. Wood. Try to find an excellent little shilling book, possibly out of print now, called *Wild Flowers of the Year*, and utilise popular books such as Johns' *Flowers of the Field*. Enrich and vivify your pictures, as you need, by reading the works of men like Richard Jefferies and John Burroughs; and it is hardly necessary to say that Gilbert White's *Natural History of Selborne* is the field naturalist's classic. Seek also to realise what flowers have been to men in by-gone centuries—what they may still be to you—emblems and heiroglyphs. Thiselton Dyer's *Folk Lore of Plants*, and Ruskin's *Proserpina* will help you to this, and the poets even more.

Perhaps you think that this is merely "playing at Botany" (which by the way, is the

suggestive title of one of the numerous introductions to the study of flowers), but education would be surely better if it had more of the naturalness of play. I believe, indeed, that the child playing in the garden or the meadow may readily know more of the flowers than the medical student – a slave to his text book. But the path which I have sketched is not so easy as it looks; whatever accuracy and precision characterises other methods is needed here also; no blurred impressions or casual glances may be tolerated if you would know the "flower in the crannied wall."

Do not suppose that this study of the seasonal changes—"Phenology" the learned call it—means a dilletantism in science. At every point, whether you are studying buds or flowers, fruits or seeds, you must avail yourselves of all the precise analytic methods of the schools; dissecting and sectioning, drawing and experimenting; and you must, of course, make use of all the knowledge you can gather. But you will do all this with good grace, as you personally discover the need of it, in order to arrive at the solution of each month's problem.

Thus you should have a "Flora," such as Hooker's or Hayward's, and learn to use it; you should make some simple physiological ex-

periments, such for instance as growing seeds of maize in different solutions of salts; and you must have a sharp penknife and learn to dissect with perfect neatness. Yet again, to pull a plant up by the roots, instead of sitting down beside it, to tear it to pieces to count its stamens, when a breath would have disclosed them is an artless pursuit of science, and worse.

As a guide to the practical study of flowering plants—if you must have a guide—Bettany's *First Lessons in Practical Botany*, may be mentioned; in detailed microscopic analysis, the practical manuals by Professor Bower and Professor Strasburger (trans. by Prof. Hillhouse) may be used—and, unfortunately, also abused.

II.—The World's Flora.—The student should not rest satisfied with observing the march of the seasons in his own country, indeed he cannot fully understand this without a broader survey, without some pictures of countries which know no winter in their year, or of others whose summers seem to come and go in a few weeks. Let him search out in the nearest library, a famous, yet too much forgotten book, Humboldt's *Cosmos*, or at any rate run through his *Aspects of Nature*, with its passages of imperishable description; let him

read Darwin's *Naturalist's Voyage*, Wallace's *Malay Archipelago*, *Tropical Nature*, *etc.*, Bates' *Naturalist on the Amazons*, and so on, down to Miss North's *Recollections of a Happy Life (1892)*; in short, let him skim through the works of the naturalist travellers, until he has formed for himself a series of pictures of the World's flora. Brehm's *From North Pole to Equator*, which will be published this year in translation, is also most useful, though more zoological than botanical.

Nor need this study end in merely mental pictures, for in Miss North's collection at Kew, and in the collections begun in the Botanical department of University College, Dundee, and in connection with the Edinburgh Summer Meeting, there is more than the suggestion of a gallery of landscapes and vegetation, by which we may vividly realise what the world is like.

Someone has said that a true naturalist sees a tropical forest in a square yard of meadow, and it is at least true, that even without leaving our shores, the student may realise the flora of the Steppes, of the Tundra, of the Alps; or, with the help of the greenhouse, even of the tropical forest.

III.—The Web of Life.—Perhaps the

greatest debt that naturalists owe to Darwin is suggested in this phrase, "the web of life," for it was he, above all others, who led us to an appreciation of the dramatic complexity of nature. "Nature is no longer a mere confused multitude of specimens to be collected and analysed, but each organism is linked with others as consecutively as in the 'House that Jack built'; nay, with indefinite cross relations as well; what seemed a unit is a link; what seemed a chain is but a thread within the labyrinthine web of nature."

Starting, for instance, from Darwin's familiar illustration of the links connecting cats and clover, we may follow this fascinating study of inter-relations into infinite detail, until the image of the web becomes vividly real to us. Thus there are the relations between flowers and insects to be observed and pondered over, with help for instance from Hermann Müller's *Fertilisation of Flowers* (trans. by Prof. D'Arcy Thompson, London, 1883), Kerner's *Flowers and their Unbidden Guests* (London, 1878), Sir John Lubbock's *British Wild Flowers considered in Relation to Insects* (London, 1875), and Henslow's *Making of Flowers* (London, 1891). The relations, both friendly and hostile, between plants and ants; the work of the prolific

aphides in making 'honey-dew' and the manner in which these pests are exploited in turn by the ants; the ravages of injurious insects (see Miss Ormerod's excellent Manual, 2nd edition, London, 1891); these and many other sets of facts will lead the student to understand what is meant by the web of life. See also the author's *Chapters in Modern Botany* (London, 1893), and Mr. J. Arthur Thomson's *Study of Animal Life* (London, 1892).

Just as animals struggle with one another, and help one another, so it is with plants, though we cannot suppose them to be aware of their inter-relations, as most animals are. Make a study of a hedge row; realise the struggle for room, for air, for light; see how a climber like Jack-Run-the-Hedge scrambles on the shoulders of his competitors, or how others are saved by their finely cut leaves, which expose a large surface to the air. Consult in this connection Sir John Lubbock's *Flowers, Fruits and Leaves*, and Grant Allen's bright papers in *The Evolutionist at large*, *Vignettes from Nature*, *Pedigree of Flowers*, *etc.* Look up *Nature*, September, 1889, for an abstract of a lecture by Mr. Walter Gardiner, on "How plants maintain themselves in the struggle for existence"; or find in back numbers of *Natural*

Science, several articles by Mr. James Rodway, on "Struggle and death in the tropical forest"; or, failing these, turn up Darwin's *Origin of Species*, and read the story of 357 seedlings, of which no less than 295 were destroyed.

Look at those Orchids and other "Epiphytes" in the greenhouse, which are able to live altogether independent of the soil, and try to find out the secret of their life. Read up, in the *Encyclopædia Britannica* for instance, the story of such parasites as mistletoe and dodder, toothwort and broom-rape. Or if that be too formidable, read Miss Gaye's charming book, *The Great World's Farm*, and the author's little book,* already cited.

IV.—The Vitality of Plants.—In our botanical studies we have above all things to realise that the plant is a living creature. Watch a tendril of the vine or the stem of the hop, and satisfy yourself that it moves. Multiply your observations, and you will find that this power of movement is shared, in some degree, by all flowering plants, though, in many, it is confined to their youth. See how the leaves of the wood-sorrel go to sleep, or how daisies close their eyes. You will find it interesting to read

* From this book—one of Murray's University Extension Series—the sentences included in inverted commas in this article have been quoted.

about the "Floral Clock," but you had better test its truth before you keep appointments on the strength of it. Touch the stamens of the rock-rose and watch them curve inwards, as they do when jostled by an insect's legs; see the stigma of the musk close on a slip of paper, as it does when a pollen grain is borne to it; watch the sundew's tentacles catch a small fly; set the mechanism of Venus' fly-trap at work; put the sensitive plant to sleep with a touch; or lay a silk thread across a tendril of the pea, and you will not doubt that plants feel. And what is true of the two master activities—moving and feeling—is true also of breathing and digesting, they are exhibited as really by plants as by animals, though the latter are, of course, the more wide-awake organisms. In this connection you will do well to read the classic work, Claude Bernard's *Phenoménes communs à la vie des Animaux et des Plantes*, and Darwin's *Climbing Plants*, *Movements of Plants*, and *Insectivorous Plants*.

V.—Analysis.—The history of Botany is in great part that of a gradually deepening analysis. The work of Linnæus was mainly that of describing external form, which he did with unsurpassed precision; Jussieu and others penetrated deeper—to a study of the individual

parts or organs; the invention of the microscope led to a recognition of the tissues and the cells, and ultimately to the study of the protoplasm or living matter itself. Similarly, when function, not form is considered, the physiological botanists have passed from a study of the life of the plant as a whole, to the discovery of the separate activities of root and stem, leaf and flower; deeper still to a discernment of the various tissues in the plant—nutritive and skeletal, conductive and glandular, and so on, and finally to an investigation of the life of the individual units or cells, and of the chemical changes in the living matter. We call the study of form and structure, morphology, the study of habit and function, physiology, and it is evident that anyone who would understand flowering plants must know both. He must understand, for instance, how Goethe's insight saw in the flower but four whorls of modified leaves—the protective leaves or sepals, the attractive leaves or petals, the pollen-making leaves or stamens, and the ovule-bearing leaves or carpels. Nor will his studies then be finished, for he must trace the tree to the seedling, the seedling to the embryo, the embryo to the egg-cell; and he must also follow the steps of those who seek to decipher

from the rocks the history of bye-gone floras, which led up to ours. In other words, the student must learn of the embryology and palæontology of plants, and having learned much, he is expected finally to face the most difficult problem of all, to enquire into the causes of what he sees, how the oak tree grows out of the egg-cell, how the flora of to-day has grown out of that of the Carboniferous ages (see the author's articles, BIOLOGY and BOTANY, in the new edition of *Chambers' Encyclopædia*, and an article on THE RISE AND AIMS OF MODERN BOTANY in the *Parents' Review, 1893)*.

According to established programmes, the student is an anatomist first, dissecting a dead 'type,' a physiologist afterwards making its parts work, possibly, if time permit, a casual inquirer into development and past history; and last of all, an evolutionist by getting up Darwin's theory as an external body of dogma. According to our view the right course of study is precisely the opposite: Darwin's habit of observation and interpretation first, physiological details afterwards, and such anatomical and historical studies as are needed at each step.

We do not suppose that the thorough student can dispense with any of the disciplines above-

mentioned; he must still study in the schools of Linnæus, of Jussieu, and of all the great masters, but no longer as a drudge hoping some day to get to the fields, rather as a field-naturalist who takes to the laboratory and the library to find the solution of the puzzles which his day's observations have brought him to face.

Like other sciences, Botany has its classic books, but a knowledge of these will come in good time. Nor do we suppose that it is within the scope of this volume to take account of the text books of the schools. They have their place and use, but they are not for beginners. Therefore, of large books we shall mention only one—Kerner's *Pflanzenleben* (2 vols. Leipzig), which is in some ways the best of all. We believe that it is now being translated.

But there are many small books which a beginner will find useful if he will only use them temperately. It will be enough to give the names of five:—

Miss Aitken—*Year of Botany*,
Masters—*Botany for Beginners*,
Oliver—*Elementary Lessons in Botany*,
Marshall Ward—*The Oak Tree*.
Lindley—*School Botany*.

"But, as teacher and student usually end as they began, let them begin as they would end;

neither with conning an inventory of plant mummies, nor with the tissue unwrapping of samples of these; but with childlike watching, scene after scene, of the actual drama of nature, in which life inter-acts with life, and fate with all."

The Study of Mosses.

By ELLA M. TINDALL

On the Study of Mosses.

TO the field botanist who devotes himself exclusively to the study of flowering plants, Winter must of necessity be a blank time. He looks with sorrow on the falling leaves of October, knowing that till March, or even April, his work is over; but, should he turn his attention to the more inconspicuous, but not therefore less interesting group of plants, that clothes our walls and carpets our woods, he will find that Autumn and Winter are no longer devoid of interest, and a fresh field will be opened to his research. Nature assumes a new aspect, and places heretofore avoided are now sought after; a bog becomes a joy, a swamp a happy hunting ground, and a damp ravine, especially if it boast a waterfall, Paradise.

No elaborate appliances are needed for collecting mosses; a vasculum, a good pocket lens, and sheets of paper in which each specimen may be folded as it is gathered, will suffice for the outdoor work. If the collector be a lady, thick boots, short skirts, and a cloak that

will enable the wearer to collect in rain, or under dripping rocks with impunity, are desirable; she must not mind wet feet or mud-besprinkled garments, long walks or scrambles among rocks and briars; for love of work she must rise superior to all difficulties, and the pleasure of finding a rare species will be a full reward.

The study of mosses has one great advantage, that it can be carried on in all parts of Britain, though the rarer kinds must be looked for in the limestone districts, among the mountains of Scotland and the English lakes, on the West Coast of Ireland, and on the clay of the Sussex Weald.

Once gathered, mosses should not be kept in their damp state, but should be carefully washed in water till all the earth is removed, and then laid out on paper to dry. When dry they can be put aside in envelopes made of cartridge paper, till the collector has time to examine and name them. A portion of the plant should then be placed in a watch-glass, and when all the air has been expelled by immersion, and the plant has absorbed sufficient water to enable it to resume its normal form, it is ready for identification.

In beginning the study of mosses, the student

should first learn to distinguish the several parts of his specimen, and then make himself master of the technical terms applied to them, and the meaning of those terms; since technical terms have no value unless their meaning and correct use be known. In Botany, most of the terms in use are limited to that science, and have Greek or Latin derivations; consequently, they will be often new to a beginner, and a conversation between Botanists on their own subject is almost unintelligible to ordinary mortals.

What is commonly called the *Moss Plant* is often of considerable size, and can be seen with the naked eye to consist of a stem, which may be either branched or simple; this bears numerous leaves, which frequently cover the stem, so that its surface cannot be seen. Its base is fixed in the soil or other substratum by numerous fine filaments, hardly visible to the naked eye; some of these may be above ground and green—these are the *protonema*; others are brown and ramify in the soil—these are the *rhizoids*. The fruit, to which the term *sporogonium* is applied, consists of a *capsule* containing *spores*, placed either at the end of a stalk, the *seta*, or else sessile among the leaves of the moss plant. The *spores* are small,

dust-like bodies, from each of which a new individual may grow. A short account of the life history of mosses, illustrated with figures, is given in one of the London Science Class Books, "Outlines of Classification of Plants," by Dr. McNab.

The student will spare himself many anxious hours, and frequent mistakes, if, instead of attempting to identify mosses by their leaves alone, he will be content at first to work out those only which he finds in fruit. The preliminary classification of mosses into *Acrocarpous*, *Pleurocarpous*, *Cladocarpous*, *Cleistocarpous* and *Anomalous* groups depends on the position and form of the fruit. In the *Acrocarpous* mosses the fruit is terminal, *i.e.*, placed at the apex of the stem; in the *Pleurocarpous* mosses it is lateral, *i.e.*, placed at the side of the stem; in the *Cladocarpous* mosses it is placed at the end of a short branch; in the *Cleistocarpous* mosses, the capsule has no distinct lid, but bursts irregularly when the spores are ripe. In the case of the two *Anomalous* mosses, *Andræa* and *Sphagnum*, *Andræa* is distinguished by the capsule opening by four slits at the side; *Sphagnum* can be unfailingly recognised by the leaves alone, the cells of which are traversed by spiral fibres.

When, by the study of mosses in fruit, he has become familiar with a certain number of species, the student may be able to recognise a further number by the leaves alone. He will know the upright stems of the *Polytricha*, the heath-mosses, looking like tiny fir trees; the feathery fronds of the *Hypnaceæ*, the *Pleurocarpous* mosses, common in our woods; the closely packed tufts of the *Tortulæ*, and the silvery patches of *Bryum argenteum*, beautifying many an old wall and garden path; and the vivid green of the *Sphnagnaceæ*, the bog mosses, sure sign to the wary traveller of dangerous ground.

For indoor work, a good microscope with an inch lens for ordinary use, and a half-inch lens for examining the *areolation* (form of the cells) of each leaf, is almost indispensable. The Star Microscope, manufactured by Messrs. R. and J. Beck, of 68, Cornhill, is well adapted for this purpose; the price is from three to four guineas. A dissecting stand, which can be made at home, a pair of forceps, a small scalpel, a glove maker's needle, a soft paint brush, some watch-glasses, slides, and cover slips, complete the list of apparatus. If the student wishes to mount his specimens permanently, glycerine jelly is the best medium for their preservation, and Canada Balsam dissolved in

benzole can be used for hermetically sealing or "ringing" the cover slips. An excellent handbook, the "Illustrated Guide to Mosses," by the Rev. H. G. Jameson, has lately been published. Each species is carefully illustrated, and the letterpress takes the form of a key, a system which is of the greatest assistance to the beginner, who does not at once know in which genus to place his moss. Many books more elaborate and expensive have been written, but this one meets the beginner's requirements, and will be found thoroughly satisfactory for practical use.

Having decided, by the position or form of the fruit, in which division the moss to be examined should be placed, the student should carefully remove the hood or *calyptra*, and lid of the capsule, noticing their shape; he will be able to see with a pocket lens whether the mouth of the capsule is bare, or whether it is protected by a delicate fringe, the *peristome*. It is by the shape and number of the divisions or *teeth* of the peristome, when present, that the further classification of mosses is determined. In order to see the peristome well, the capsule should be cut open lengthways, and the spores washed out, or brushed away with a soft paint brush. The capsule should then be mounted in

water on a slide with a cover slip over it, and placed under the microscope; it will then be easy to determine whether the peristome is single or double. A double peristome consists of an outer row of entire teeth, usually brightly coloured, and an inner transparent membranous fringe, more or less regularly divided into teeth. A single peristome consists of only one row of teeth, either entire or cloven to the centre or base.

The number and form of the teeth of the peristome having been ascertained, the leaves should next be examined. Three or four should be carefully removed from the stem and mounted in water in the same way as the capsule. The points to be determined are whether the leaf is thickened throughout by vertical plates of cells, or transparent, and, if transparent, whether the cells are similar throughout, or traversed by one or two veins or nerves; whether the edge is entire or toothed, or bordered. The shape and inclination of the leaf, and the form and arrangement of the individual cells, are important factors in determining the species to which the plant belongs.

Apart from the interest of collecting and identifying the different species of mosses, the

careful observer will notice that the forms which the peristome takes are full of beauty, and of special interest in the various ways in which the teeth are instrumental in scattering the spores. In the *Bryaceæ* and *Hypnaceæ*, the peristome, when moistened by rain after a dry day, unfolds by a series of jerks; the spores, being caught by the projections on the teeth, are thrown a considerable distance as the teeth spring into an erect position. This process may be observed under the microscope, by placing a ripe capsule without its lid on a warm slide and breathing gently on it. In the *Polytrichaceæ*, the short teeth of the peristome are attached to a flat membrane, the *epiphragm*, which covers the mouth of the capsule; the teeth are slightly arched and placed at a short distance from each other, so as to leave a row of small holes round the edge of the epiphragm. This peristome is not hygroscopic (affected by moisture), but as the spores ripen, the capsule, at first erect, gradually bends over, the mouth becomes inverted and, at the slightest touch, the spores fall out in a cloud of fine dust.

There is another small group of green plants. the *Hepaticæ* or *Liverworts*, which the student cannot fail to encounter in his search for mosses, especially in and by streams and in damp

woods ; some of the smaller species are epiphytic on mosses, and grow so mixed up with them, that they are frequently mistaken for each other.

Four families of *Hepaticæ* are represented in Britain :—The *Anthoceroteæ, Ricciaceæ, Marchantiaceæ* and *Jungermanniaceæ.* The first three genera are *Frondose,* with no differentiation into stem and leaf, but the last, the Jungermanniaceæ, contains both Frondose and Foliose species. The Marchantiaceæ abound in most districts, on wet rocks, walls, or the sides of ditches; the plant consists of a green thallus or frond, with a midrib, growing flat on the ground, and attached to it by numerous rootlets on the underside. The surface is divided into rhomboidal areas ; in the centre of each is a round orifice, the stoma or breathing pore, giving the plant a dotted appearance. The *Sporogonia* (fruits) are placed on the underside of umbrella-shaped branches, which rise erect from the surface of the frond, except in the rare species, *Targionia,* where the sporogonium is placed on the underside of the frond The sporogonium consists of a round, dark coloured, thin-walled capsule, filled with spores and threads containing spiral bands, the *elaters,* which, when the capsule bursts, assist in scattering the spores.

The *Ricciaceæ* and *Anthoceroteæ* are comparatively rare. The Ricciaceæ are small plants, dichotomously branched, without pores on the surface of the frond. The sporogonia are sunk in the thallus, and contain spores but no elaters. The Anthoceroteæ are distinguished by a slender, erect, pod-like fructification, which splits into two valves when ripe; it contains spores and elaters, but the latter have no spiral bands; there is only one grain of chlorophyll in each cell, the fronds are translucent, nerveless, and proliferous at the edges.

The Foliose Jungermanniaceæ are frequently mistaken for mosses, but may be known from them by the *distichous* (in two rows) arrangement of the leaves on the stem, the absence of veins in the leaves, which are never more than one cell in thickness, by the pellucid character of the whole plant, and by the fruit. The sporogonium consists in the Jungermanniaceæ of a dark-coloured, thin-walled capsule, filled with spores and elaters, splitting into four valves when ripe, and is placed on a delicate hyaline stalk, surrounded at the base by a leafy envelope, the *Perianth.* The plant consists of a stem frequently creeping, with two rows of leaves on its upper face; in many species a third row of smaller leaves (usually differing in form from

the surface leaves), the *stipules* or *amphigastria*, are present among the rootlets on the under side of the stem.

Some of our commonest bog plants are included in the Frondose Jungermanniaceæ, *e.g.*, the *Pelliæ* and *Aneuræ*. These differ from the *Marchantiæ* in the translucent fronds, the absence of pores on the upper surface, and the position of the fruit. The fruit is similar to that of the Foliose Jungermanniaceæ, and rises, surrounded by an involucre, direct, in Pellia from the upper, in Aneura from the under surface of the frond.

Liverworts are more difficult to preserve than mosses, as they are so soft and full of sap, that when dry they shrivel up, and many species are then quite unrecognisable till carefully soaked out.

No complete book on the British Hepaticæ has yet been published; Sir William Hooker described about eighty species in the second volume of the British Flora, published in 1832; but since then more than a hundred species have been added to the list. Dr. Spruce's monograph on *Cephalozia* is invaluable to the advanced student, but treats only of that genus. It is, therefore, impossible to suggest a systematic work to the beginner, unless his

knowledge of Latin or German be sufficient to enable him to work easily in those languages.*

One word in conclusion. A very small quantity of each Moss or Hepatic is sufficient for preservation as a herbarium specimen, or for investigation; therefore, let not the joy of the collector, in finding a plant hitherto unknown to him, lead him to gather all he sees. Through thoughtlessness in this respect rare plants may be exterminated; the goose is killed that lays the golden eggs. With this warning, the study of mosses may be commended to all lovers of nature; it sharpens the powers of observation, it quickens the sense of sight, it provides an object for a country walk, even in the gloomy months of winter; the proverbial weariness of a rainy day will be dispelled by the interest it affords in classifying and mounting the gatherings of brighter hours; and it may even settle that oft-debated and much vexed question: "Where shall I spend my holiday next year?"

LIST OF BOOKS ON MOSSES AND HEPATICS.

"Illustrated Guide to British Mosses," by the Rev. H. G. Jameson; price 7s. 6d. To be obtained from the Author, 6, College Road, Eastbourne.
"British Moss Flora." R. Braithwaite (illustrated).
"Synopsis of the British Mosses" (not illustrated). Hobkirk. Price 7s. 6d.
"Classification of Plants," by W. R. McNab; price 1s. 6d.
"Synopsis Hepaticarum" (not illustrated). Gottsche, Lindenberg & N. ab Esenbeck. 12s.
"Die Lebermoose" (illustrated). G. Pabst.

* Since this chapter was written a "Handbook of British Hepaticæ" has been published by Dr. M. C. Cooke.

Fungi.

By Miss LORRAIN SMITH.

Fungi.

THE Fungi form such a natural, well-defined group of plants, that all of us, more or less, know a fungus when we see it; few, however, have any conception of the immense number and variety of this class of plants. In our own country there are double the number of species of fungi that there are of flowering plants, and altogether there are known to science 40,000 species. Our moist climate favours their growth, and thus our fungus-flora is exceptionally rich. A successful collector may any day discover a new plant, or prove that those marked "rare" are only rare because there is no one to look for them.

The degenerate habit of life of the fungi is largely due to their want of chlorophyll, the green colouring substance by which all other plants, a few parasites excepted, convert atmospheric carbon into food material. The fungi cannot do this, so they seek their food among substances that have been prepared by green plants as their own food, and thus are in much the same position as animals in regard to their

mode of getting a living. When they live on dead organic matter, like the moulds on cheese, bread and jam, dead leaves and wood, they are called Saprophytes, and when they prey on living plants and animals, they are called Parasites. The economic interest for us may be indicated by citing the dry-rot in the timbers of our dwellings as an example of a saprophyte, and the potato-disease fungus as an example of a parasite.

The mushrooms are among the best known members of the whole plant kingdom ; they are placed in a large sub-division of the fungi called the *Basidiomycetes.* When the mushroom, which is the fruit of the plant, emerges from the soil, it looks like a little round ball, but gradually the stalk elongates, and an umbrella-like head, called the *pileus* or cap, is formed, the outer part of which is often brilliantly coloured. In some species there is a *volva* or veil covering over the fungus at an early stage, but this bursts as the mushroom expands. If we examine the under part of the *pileus,* we find radiating rows of gills, very crowded, but all distinct from each other. These gills are the spore-bearing portion of the plant ; their surface is covered with little branches termed *basidia,* on the ends of which are borne the ripening

spores. This under part of the *pileus* is nearly always less brightly coloured than the upper part, but the spores are of various hues, white, pink, brown, purple or black. If the cap be removed from the stalk and placed on a sheet of white paper, a delicately-tinted deposit of spores is formed, the colour of which helps greatly in the determination of species. In other genera, the gills are replaced by spines projecting downwards (*Hydneæ*), or by pores (*Polyporeæ*). Those with pores on the under surface are very common in our woods, growing on the ground or on trees.

In the *Clavariæ*, or club-fungi, the spore-bearing layer surrounds a short upright stalk, with blunt ends, and very often branched. They vary in colour from pure waxy white to a beautiful deep orange yellow, and are often found in damp fields, or among moss.

The puff-balls (*Lycoperdaceæ*) contain, when mature, a powdery mass of brown or black spores, which are scattered everywhere when the outer skin is broken. At an early stage the interior is divided up into chambers lined with the spore-bearing basidia, but as the spores ripen the rest of the tissue decays and disappears. *Phallus impudicus* is another very well-known Basidiomycete ; it has a hollow stalk, the top of which

is surrounded by a series of closed chambers, In this case the outer wall decays, and the chambers with the spores are laid bare. It is a very objectionable fungus; the smell of the healthy normal plant is so offensive that it is almost impossible to examine it.

These larger fungi are very easily broken or bruised; this arises from the delicacy of the tissue. It is entirely built up, as in all fungi, of simple filaments of cells termed *hyphae*, which may be simple or compacted together to a solid structure. It exists underground, as a white felt or spawn—the *mycelium* of the plant—or it is hidden away among the tissues of the host-plant. When any fungus becomes visible to us, we may know that it has reached the highest stage of its existence, the production of spores, and will repay examination. The spores are borne on the hyphae, and on this method of their growth is based the system of classification.

A large series of fungi, the *Uredineae*, have been classed along with the Basidiomycetes from the position of certain spores at the apex of special hyphae. They are all very minute parasites, forming rusts on living plants, and have a remarkable life-history. The corn-mildew (*Puccinia graminis*), one of the best

known of the Uredineae, passes the early part of its life on the leaves of the Barberry bush The mycelium forms a little round fruit, called a cluster-cup, which bursts the epidermis of the leaf, and from the base of the cluster-cup thus formed rise the fertile hyphae, which bud off orange-coloured spores. These germinate only on corn; the spore lights on the young corn-plant, and grows out into a little filament, which penetrates the tissue of the new host. The fungus now produces tiny orange-coloured globules, called *uredospores*, in immense numbers, which are scattered by the wind, and serve to disseminate the disease. As winter approaches, brown resting spores, called *teleutospores*, are produced. They are generally larger, and have a thick coating, which enables them to persist through the cold weather. When spring returns, they germinate on the Barberry, and the life-cycle begins afresh.

The *Uredineae* include many beautiful forms, the manner of fruiting being very varied. Some of the species confine themselves to one host, producing in turn the different spores; others have become still less enterprising, and have only one kind of spore. They form little warts and patches on the stalk and leaves of many flowering plants and ferns. In spring, a yellow

spot on the leaves of the Lesser Celandine betrays the presence of *Aecidium Ficariae*, one of the earliest to make its appearance; in autumn teleutospores are to be found as dark coloured dots and streaks on the leaves of grasses and other plants.

Another large group of fungi, called *Ascomycetes*, form their spores in tubular cells called *asci*. The homely familiar yeast-plant is one of the simplest and most useful members of the group. Owing to its rapid growth, it induces great changes in the food-material provided for it, a process which has been utilized in the service of man. The truffle is also a much esteemed member of this order which develops underground in beech or oak woods. Among the most lovely of all are the cup-fungi (*Peziza*), which grow mostly on dead wood and stumps. The hollow cup forming the fruit is filled with spore-containing asci, and in some species is of the most beautiful colours, red, yellow, etc. There are many other genera of equal interest, such as *Nectria*, which forms little reddish swellings, with flask shaped fruits, on the branches of our currant bushes, and the *Erysipheae*, which occur as a white felt or mildew on the leaves of various plants. The asci of *Erysiphe* and allied genera, are enclosed in a beautiful case

which looks like a little black dot, and is often provided with appendages and hooks by which it attaches itself to its host.

There is one remarkable family, of composite character, the Lichens, consisting of fungi, which, instead of robbing their neighbours of food supply, have entered into partnership with minute Algae, and give and take in the most friendly manner. The fungus and alga grow and increase together with mutual benefit. In nearly all cases the spores are formed in asci which are to be found at the tips of the plant or in little cups. Lichens are very widely distributed plants, reaching the utmost limits of vegetation, and clothing the rocks of the highest hills. Some hang in waving tufts from the pine trees, others hold aloft their fairy trumpets from the tops of stone walls; the grey, yellow or brown stains on stones are caused by minute lichens, which grow where nothing else could. In deference to their green alga comrades, they rather seek the sunlight, and avoid the cellars and shady nooks that form the favourite haunts of fungi.

Among the more simple forms of fungi are Bunt and Smut that attack the corn grains, converting the ear of corn into a mere mass of brown or black spores, and the *Phycomycetes*,

which include among others Salmon disease and Potato disease. The latter caused the almost total destruction of the potato crop in 1845, and reappears in our fields every autumn, when the weather is moist and warm. The mycelium in the tissue of the potato-plant sends out hyphae through the breathing pores of the leaves and stem, delicate fairy-like branches that bud off pear-shaped spores. These are wafted by the wind to other plants, and when they alight they germinate in a remarkable way ; moving bodies issue from the spore, swim about in the drops of moisture such as dew on the leaves, then finally settle and grow out into a filament which penetrates the leaf. The fungus extends through the stalk down to the tuber, and quickly renders the potatoes quite worthless. Most of the members of this class are troublesome little pests, but they can easily be grown and watched under the microscope, and this alone would render them favourite objects of study.

While the other members of the vegetable kingdom, from the Algae onwards, have a more and more perfected method of seed-bearing, the fungi have distinctly degenerated. Some of the simple alga-like forms possess, like the Algae, the double method of reproduction by fertiliza-

tion and by vegetative spores (that is, by certain cells which are budded off and are capable of growing into a new individual), but in the more complicated fungi, such as the mushrooms, the latter method of reproduction alone prevails. They have acquired a marvellous power of adaptation, and of changing their forms, and they scatter their minute spores in such countless numbers that some mould or mushroom is sure to grow wherever a suitable soil and temperature is provided.

Among the Basidiomycetes are found most of our edible fungi—Mushrooms, Chantarelles, Boleti, etc., and many, we are told, ought to be used as food which are now allowed to go to waste. They are exceedingly rich in nitrogenous substances, and might form a delicious and valuable article of diet. On the other hand, some are virulently poisonous, and even the safe varieties are hurtful if not gathered when they are fresh. Much, also, depends on the cooking; enthusiastic fungologists usually add cooking recipes to the description of edible fungi.

A most interesting scientific account of fungi, their method of growth and life-histories, is included in "A Handbook of Cryptogamic Botany," by Bennett and Murray (Longmans,

Green & Co.) A list of books is appended that will be found helpful to collectors.

"Guide to Sowerby's Models of British Fungi," with 93 figures, price 4d. Published by the Trustees of the British Museum (Natural History), Cromwell Road, S.W.

"British Edible Fungi," by M. C. Cooke (Kegan, Paul and Co.)

"Diseases of Field and Garden Crops," by Worthington G. Smith (Macmillan & Co.)

Seaweeds.

By E. M. HOLMES, F.L.S.

Seaweeds.

"WHAT are you looking for?" is a question not unfrequently asked by young folks when they see an algologist wading in the pools on the shore; and on several occasions a peep through a lens at the objects of search has been known to give considerable pleasure to the questioner. Many seaweeds are so beautiful in colour and so exquisite in form, are so easily mounted on paper, and preserve their colour for so many years, that it is strange so few take an interest in them.

There is also quite a healthy excitement aroused by hunting for new varieties along the beach, and great pleasure to be derived from them when found, both in examining them and in exercising manipulative skill in mounting them as naturally and artistically as possible.

A habit of minute and careful observation is engendered in collecting specimens of different kinds, and in comparing them under the microscope, and patience is unconsciously acquired in mounting them. An onlooker watching the process frequently observes, "I could never

have the patience to do that," but the manipulator becomes so absorbed in spreading out every little branch perfectly, that the work becomes a pleasure, rather than a toil. In wet weather, a handful of seaweed, gathered in a few minutes on the beach, will supply material for amusement for a whole day, if examined under a microscope.*

By selecting pieces of good colour, and by the exercise of a little artistic skill, very pretty birthday or Christmas cards may be made with seaweeds, appropriate mottoes being printed on them by hand in gold or coloured inks.

The chief difficulties that confront the young algologist are (1) how to get specimens of good colour, (2) how to find out their names, (3) and how to mount them.

A few hints as to the best methods of overcoming these difficulties may therefore prove useful. The finest and best specimens are always found growing, and can only be got at by wading in the pools or by examining buoys and wooden piles, etc., from a boat. To wade with comfort, waterproof leggings or boots are a prime necessity. Those sold under the name of fishing stockings, and reaching considerably above the knees, answer the purpose admirably. These,

* A portable microscope, for seaside use, may be obtained for about £3.

together with a pair of sand-shoes, may be carried in a bag, and a pair of light elastic-side boots used for walking to the shore. On arrival there, the boots are exchanged for the fishing-stockings, and the sand-shoes are worn over the latter so as to prevent their being cut by the rocks.

Accoutred thus, comparatively large pools may be searched, and all kinds of treasures discovered in their recesses. On leaving the shore, the boots are resumed, and the seaweed-hunter walks home as dry and as comfortable as if he had never been in the water. For ladies, waterproof boots reaching to the knees can be used, and can be put on before starting from home. For carrying home the specimens, three small American-leather bags, or sponge-bags, with a small pickle-bottle, and a few pieces of old washed muslin, are all that is required. But a knife, for cutting specimens off woodwork, and a magnifying-glass, such as is used by jewellers, for examining the more delicate species, will be found useful.

The best time to visit the shore is on the two days preceding and following the new and full moon, when the lowest of spring tides uncover rock-pools not visible during ordinary tides. The hunt should begin about an hour before the tide

turns, and be continued until a film of scum raised by the incoming tide in the pools indicates that care must be taken not to let the tide cut off the retreat round projecting headlands or ridges of rock. In some places, as at Filey and at Sidmouth, it is particularly necessary to watch the incoming tide.

The finest coloured red-weeds will be found growing almost in the dark, under overhanging ledges of rock, whilst the green and brown species grow in the sunnier parts of the pools. It should be borne in mind that different species grow under different conditions.

Thus, some grow on the shores of the open sea, where the water dashes roughly against the rocks, and are not found in sheltered bays, where other and quite different species grow. Other species grow in estuaries where the salt water is diluted by river water. Many of the glutinous, or slippery species, grow on the sea-grass (*Zostera*), which is found on muddy or sandy shores. Others again occur on large boulders, under cover of the larger and more leathery species, and some in the pools of salt marshes overflowed by the sea. Wherever the conditions vary, different species may be looked for. Some species grow only in deep water, where the rocks are never uncovered, and these

are rarely met with except after a storm, when they may often be found attached to the rough-stemmed oarweed (*Laminaria*) or to the sea-laces (*Chorda*) thrown up on the shore.

When there is a sudden fall in the barometer indicating a gale, a visit to the shore is always advisable, for the weeds are often torn up by storms at a distance, and thrown up on the beach before the storm actually arrives; when it does come, it soon tears the cast up weed into shreds, or buries it in sand.

In collecting specimens, the brown, green, and reddish species should be kept apart in separate bags. Some species, such as *Desmarestia*, *Halyseris* and *Wrangelia* lose their colour on exposure to the air, and must be carried home in sea water. A little experience will, however, soon teach the observer the peculiarities of the different species.

It is advisable, before leaving the shore, to find a quiet, clear pool, and to carefully wash the specimens clean, taking the opportunity of reserving only the most perfect specimens.

On arriving at home the specimens are placed in bowls of clean sea water (fresh water often bursts the cells and discharges the colouring matter on the paper), and a specimen selected and placed on a white dish (a plaque, such as

are used for painting on, answers well.) Any branches that stand up or prevent the clear display of the branching of the plant may be pruned off with a knife, or if small, with the sharp edge or point of a porcupine quill.

The specimen is then placed on a second plaque with clean sea water in it, and a piece of stout white drawing paper or demy paper slipped under it. A finger of the left hand is used to keep the specimen in the middle of the paper, and a porcupine quill is used to spread out the branches distinctly, beginning at the bottom with the larger branches, and gradually drawing the paper out of the water until the whole is spread out neatly. This requires a little practice to do well. If the branches run together at the tips, the circumference of the specimen may be dipped under the edge of the water and the tips floated out again naturally, withdrawing the specimen very gently from the plaque or dish. In the more delicate species, in which the individual branchlets are not easily distinguished by the naked eye, the branches may be brushed out in the water with a camel's hair pencil, moving the brush from the centre towards the circumference of the plants. The paper, with the seaweed upon it, is then laid on a sheet of stout blotting paper, and a piece

of old muslin laid upon it. New or unwashed muslin will not do, since the size or "dressing" on it causes it to adhere to the seaweed. By the time that the sheet is covered with specimens, the excess of moisture will have been absorbed.

The specimens are then placed on a sheet of blotting paper on a board, and two other sheets of blotting paper placed over them. When a pile of sheets has been made, another board is placed on the top, and gradual pressure applied by means of weights. For this purpose bricks wrapped in newspaper answer very well, or the upper board may be replaced by a flat box, if obtainable, such as Wellington knife polish or mustard are packed in, as the bricks are easily held in it. The blotting paper should be changed in two hours, and again in twelve, by which time the specimens are usually dry enough to remove the muslin. Gelatinous, or slippery algæ, may be spread out on paper and left until nearly dry, when the under surface of the paper may be moistened before pressing them. Large, coarse, leathery species may be hung up to dry, and, when dried, should be immersed for about five minutes in fresh water to remove the salt they retain, before pressing them. When pressed, they may be made to adhere to paper by means of thick gum; this is spread thinly

on a narrow slip of card, which is inserted by the right hand under the main stems and branches, the left hand being used to press the specimens down as the card is withdrawn. If required for seaweed baskets, the weeds should be placed between two pieces of old muslin before being pressed. For these baskets, zoophytes are often largely used. These may be distinguished from seaweeds by their pale brown or dirty white colour and horny consistence, their open-mouthed cells, by not shrinking when dry, and by the absence of vegetable cellular structure when examined under the microscope.

The most beautiful and brightest coloured specimens of seaweed are usually found in May and June, but very fine specimens are thrown up by storms in August and September. The common oarweed (*Laminaria stenophylla*) is found in fruit in June, but the other kinds of oarweed are best collected in February, when the fructification is present on the top of the frond, and the curious growth of the new frond below the old one can be seen.

During the winter months few species possess much beauty, but from November to April many of the commoner species are in fructification, and are exceedingly instructive when examined under the microscope.

Some of the best shores for seaweeds that I have visited are those of Jersey, Weymouth, Plymouth, Sidmouth, Falmouth, Torquay, Padstow, Bognor, Ilfracombe, Berwick-on-Tweed, Cumbrae, and at very low tides, Shoreham and Brighton, Worthing and Hastings. But there is little doubt that there are many other excellent localities as yet unexplored in Ireland, West of Scotland, the Shetland Isles, Wales, and Cornwall, etc.

In most large towns there is generally a collection of seaweeds accessible for reference in the local scientific institute or museum. A comparison with such a collection is the best way for a beginner to identify specimens. When he has formed some idea of the commoner species, he may look carefully for fructification, and collect only specimens bearing it.

Delicate species, with slender filaments only one cell thick, are easily recognised under the microscope, but species having a complex structure must be cut transversely with a very sharp knife, so as to display their internal structure. This is best done by placing the weed, or a portion of it, on a piece of card, pressing it down with the forefinger of the left hand and using a penknife in the right hand, so as to cut a thin transverse slice, the thinness

being regulated by a slight movement of the nail of the hand holding the weed. The cut should be made by a sliding or saw-like movement. If sufficiently thin, the structure is easily seen when placed in a drop of water on a glass slide with a thin cover glass over it, and examined under the microscope.

There is no better way than this of distinguishing the different species of Marine Algae. When the fructification is met with, it affords confirmatory and decisive evidence.

There is no work giving illustrations of all the British Marine Algae, but a revised list, reprinted from the *Annals of Botany*, of all the species known up to two years ago, is obtainable from the "Clarendon Press" Office, Amen Corner, Paternoster Row (2s. 6d.)

The best book with which to compare specimens is *Harvey's Phycologia Britannica*, but it is too expensive for ordinary purposes. Two excellent little books—*The Marine Botanist*, I. Gifford (Longmans), and *British Marine Algae*, by W. H. Grattann (*Bazaar* Office), are now out of print, but are sometimes obtainable at second-hand booksellers. There are, however, three books still obtainable: Landsborough, D., "A Popular History of British Seaweeds" (Lovell Reeve); Gray, S. O.,

"British Seaweeds" (Lovell Reeve); Clarke, Mrs. L. Lane, "The Common Seaweeds of the British Islands" (Warne & Co.)

Minerals.

By G. T. PRIOR, M.A., F.G.S.

Minerals.

THE best preparation for the beginner who is thinking of taking up the study of minerals, will be to learn to look out upon the inanimate world around him with eyes more careful to observe its beauty and diversity of structure, than hitherto.

Just as, amongst plants and animals, he has long since learned to recognize a wonderful variety of types, so he will find that inorganic Nature is by no means so monotonous in appearance as he may, perhaps, have been in the habit of thinking. A glance at the railway cuttings during a journey, or at rugged mountain scenery, where the rock features are not wholly concealed by vegetation, or, better still, an examination of the bare exposed cliffs round our coasts, will soon convince him that the masses of inorganic material which make up the earth's solid crust, vary considerably in colour and structure. His geological friends will tell him that these different kinds of rock which he has observed may be grouped into two great

divisions, according to their mode of origin—viz.: (1) Igneous rocks, or those which have been erupted from volcanoes or have consolidated from a molten state beneath the surface; and (2) Sedimentary rocks, or those which have been formed by the accumulation, at the bottom of former lakes and seas, of fragmentary material derived from pre-existing rocks, by the wear and tear of wind and rain, and other natural forces.

The beginner should collect a few specimens of some of these different rocks, and, by closer examination, seek to determine the cause of the different appearances they present. He will find that, whereas some appear quite homogeneous and uniform, others are coarse-grained and manifestly made up of a number of distinct substances. A fragment of the igneous rock known as granite, will be clearly seen to consist mainly of an intimate mixture of three substances, which differ so markedly in appearance, that, if the rock be coarsely powdered, the particles of each kind may be readily separated by hand for closer examination.

These ultimate products, then, which constitute, either singly or in intimate association, the rock masses forming the earth's solid crust; or which occur, in forms of wonderful beauty,

filling cavities or lining veins and crevices in these rock masses, are called mineral species.

The study of their properties, morphological, physical, and chemical, as well as of their mutual association and modes of occurrence and origin, constitutes the science of mineralogy.

The importance of such a study it is almost impossible to exaggerate, and in a country like England, which owes so much to its mineral resources, its comparative neglect is to be regretted.

The student beginning the study of minerals, will be inclined to complain of the difficulty he will experience in collecting specimens. Whereas the botanist or entomologist may return from a casual walk in the country laden with spoils collected from the multitudinous forms of plant and animal life around him, the seeker after minerals may only succeed in obtaining a few rough specimens of such minerals as quartz, calcite, or iron pyrites, presenting little of that perfection of crystal development and brilliancy of lustre which have dazzled his eyes in the specimens he may have seen in some large collection. Well crystallised specimens occur, generally, only in mineral veins, or lining cavities in rocks, so that operations on a large scale are, as a rule, required to reveal them.

In a mining region, such as Cornwall, the collector may meet with better fortune, and may obtain, from the miners, specimens, more or less perfect, of the ores of tin, lead, copper, etc.

But before he may have the opportunity of visiting such localities, he must not allow himself to be discouraged, but should set to work upon the specimens of the more common minerals he has already collected, and make his first observations upon them.

In the first place he will, naturally, make careful note of their more obvious external characters, such as colour, transparency and lustre. This last property will not, at first, appeal very strongly to the beginner, but, as his eye becomes better trained, he will often find it of service in discriminating between species. It will mark a red letter day for him, when, like the expert jeweller, he can clearly note the difference between the light reflected from a glass surface and that from the face of a diamond.

The most important of the external characters of minerals is, of course, the outward form which they assume. One of the first observations made by the collector of minerals will be that they seldom exhibit the graceful curved surfaces so characteristic of plant and animal

life, but generally occur in crystals, *i.e.*, in forms presenting a number of flat surfaces, inclined to each other at various angles.

The study of these beautiful geometrical shapes assumed by minerals, constitutes the science of crystallography. The beginner will do well, however, to postpone the consideration of this subject until he has succeeded in collecting a number of well-crystallised specimens.

Meanwhile, after having carefully noted everything which the mere inspection of his specimens can teach him, he may proceed to make such simple experiments upon them as will enable him to determine such characters as hardness and cleavage. The student who may be in despair on the subject of lustre, will take comfort when he finds that a scratch with his knife-blade will enable him at once to distinguish between precious stones, such as diamond, topaz and sapphire, and artificial imitations of glass, or between the hard quartz and comparatively soft calcite. In the cleavage, also, or tendency to split along certain planes which many minerals exhibit, he will find a valuable means of distinguishing between species. A broken surface of quartz he will always find to be rough and irregular, whereas the tendency of calcite, when struck, to split along three

distinct planes, will be a characteristic of that mineral which cannot long fail to attract his notice.

We will now suppose that he has become possessed of a number of fairly well crystallised specimens, and is anxious to gain some insight into the mysteries of crystallography. He will find that the subject is not an easy one, and that, for its complete investigation, a certain knowledge of plane and solid geometry and trigonometry is required. So once more we must ask him not to be discouraged, but to accept the assurance that a very elementary acquaintance with mathematics indeed, will suffice, at least, to enable him to take an intelligent interest in the wonderful variety of forms assumed, not only by different minerals, but by the same mineral itself. Thus, he will soon learn to understand how all these various crystals, according to the degree of symmetry which they exhibit, may be referred to one or other of six great groups or systems, from the most symmetrical cubic crystal, which can be cut through by nine different planes, on each side of which the crystal is symmetrical, to the least symmetrical triclinic crystal, in which there are no planes of symmetry at all.

The student will find that a collection of

wooden models of minerals belonging to the six crystallographic systems will be of infinite service to him in gaining even a rudimentary knowledge of crystallography. Time spent in marking the different faces of these models, and comparing them with the real crystals he has collected, will be *well* spent. In this way he will soon learn the characteristic forms in which different minerals occur, and will be able to recognise them again when he comes across other specimens. A word of caution is perhaps necessary in the use of models. Crystals found in nature seldom exhibit the perfect regularity of form seen in the models. Owing to unequal rate of growth of the different faces, the resulting crystals are often distorted; although, according to the great law which forms the basis of crystallography, the angle of inclination of two corresponding faces remains the same for all crystals of the same mineral, however much the faces may vary in size. The measurement of such angles, therefore, becomes of great importance for the determination of species, and for this purpose very delicate instruments are used. The beginner, however, may exercise his ingenuity in devising simpler means for roughly measuring the angles of his crystals. For example, by means of two

strips of wood or cardboard, jointed together so that they may be inclined at any angle, he may succeed in convincing himself that the angle between two faces of the six-sided columns, in which the mineral quartz generally occurs, is the same for all the specimens of that mineral which he possesses.

So far the mineralogist will have concerned himself only with the external characters of his specimens, and, in fact, by observation of these alone, it is possible for him to gain, in time, a marvellously expert knowledge of minerals, which will enable him to identify a large number of them almost at a glance. The more ambitious student, however, who possesses some knowledge of chemistry and physics, will endeavour to proceed farther and to penetrate some of the mysteries of their internal structure and composition.

On the physical side, a wide field then lies open before him. By the examination of transparent minerals under the microscope, the marvellous phenomena connected with the transmission of light through them, will teach him to recognize the intimate relations existing between the internal structure of minerals, and their external crystalline form.

On the chemical side, also, he will not be

content with the mere blow-pipe examination of specimens for determinative purposes, but, by exact quantitative determinations of the elementary constituents of minerals, will endeavour to trace out the close connection between crystal form and chemical composition.

Even the beginner is advised not to wholly neglect the chemical side of the subject. If he has not access to a laboratory, a set of blow-pipe apparatus, and a few simple reagents, are not hard to obtain, and a good deal may be done with these in determining the ultimate chemical composition of his specimens. As an example of the use of chemical methods, take the case of the mineral cinnabar. However finely we may crush a fragment of this mineral, each minute speck still remains cinnabar, retaining its beautiful crimson colour, and all the other physical properties of the large fragment of which it formed a part. A simple chemical experiment, however, will enable us to go a step farther, and resolve this mineral into its constituent elements. By heating it in an open tube over the flame of a spirit lamp, we succeed in decomposing it into liquid metallic mercury or quicksilver, which collects in a brilliant ring on the surface of the tube, and sulphur, which at once combines with the oxygen of the air,

to give the characteristic smell of burning sulphur.

A property of great importance in separating and determining minerals, is the density or specific gravity, *i.e.*, the weight of a mineral as compared with the weight of an equal bulk of water. The mineral blende, one of the most important ores of zinc, and cassiterite, or tin-stone, which is the source from which the metal tin is obtained, are often somewhat similar in colour and appearance, and might very well be mistaken for each other in imperfectly crystallised specimens; but by simply weighing in the hand fragments of about the same size, it is possible to distinguish between them at once, since the tin-stone is almost twice as heavy as the blende.

It seems almost unnecessary to point out to the student who is beginning the study of minerals, the great assistance he will gain by a visit to some of the large collections in museums. To render such assistance is one of the most important functions of these institutions. But we should advise him to first use his utmost endeavours to determine his specimens for himself, before taking them to the museum to compare them with those in the collection. He must not be discouraged, also, if the poorness of his

own specimens, as contrasted with the beautiful examples of crystal development which he finds there, strikes him only too forcibly ; rather let this stimulate him to further efforts in making his own collection more perfect. The student who has the opportunity of visiting the Mineral Gallery of the Natural History Museum at South Kensington, will find there a most instructive introductory series of specimens and models illustrating the characters of minerals. A careful study of this series will be of greater assistance to him in mastering the rudiments of the subject than any number of text-books.

The difficulty in collecting specimens is naturally the greatest drawback which the beginner feels to the study of minerals. The pleasure derived from the tramps abroad, in search of specimens, in company with fellow-enthusiasts, adds a zest to the study of any branch of natural science.

For this reason we should strongly advise the student to combine with his study of minerals some knowledge of the rocks from which they are derived. This will be equivalent to a natural widening of the subject of minerals, to the consideration of their modes of occurrence and origin, the effect of which will be to double his interest in it.

The collecting difficulty then disappears; his study ceases to be a purely laboratory one. Armed with hammer and chisel, and provided with collecting bag, he may sally forth on geological excursions; and, while increasing his knowledge of the past history of the earth, by observation of the sequence of the sedimentary rocks, and by the collection of the fossils in them, will, at the same time, take careful note of any igneous rocks which he may find have been erupted through them. Unweathered specimens of these igneous rocks should be broken off, packed in paper and carefully labelled with the exact locality whence obtained.

Occasionally, in breaking off specimens, the collector may find treasure trove in the shape of cavities lined with brilliant crystals of minerals, such as zeolites, which have been formed in these hollows as the result of the partial decomposition of the surrounding rock.

Such excursions as these, besides being a source of great pleasure, will supply the student with a store of material to be worked out at leisure on his return. The examination of the various rock-specimens which he has collected, the determination of their structure, and the various minerals contained in them, will afford him congenial employment for his leisure hours

until the opportunity for another expedition occurs.

The foregoing pages will give the reader, we trust, some idea of the possibilities and scope of the science of mineralogy. He will see that the subject is a somewhat wide one, and requires, for its thorough investigation, a considerable knowledge of mathematics, physics, and chemistry. But we shall have failed in our object if we have not made it clear that, in spite of this, it is not necessary to be either a great mathematician, physicist, or chemist, in order to be able to take an intelligent interest in minerals, and to learn to appreciate the wonderful beauty and variety of structure of these flowers of inorganic Nature.

Appended is a list of books recommended to the beginner.

L. Fletcher. "An Introduction to the Study of Minerals." (Published by the Trustees of the British Museum.)

F. H. Hatch. "Mineralogy" (Whittaker & Co., London).

H. P. Gurney. "Crystallography" (Society for Promoting Christian Knowledge, London).

A. H. Church. "Precious Stones" (Chapman & Hall, London).

A. Geikie. "Geology." Science Primer (Macmillan & Co., London).

F. H. Hatch. "Text-Book of Petrology" (Swan, Sonnenschein & Co., London).

Grenville A. J. Cole. "Aids in Practical Geology" (Griffin & Co., London).

F. Rutley. "The Study of Rocks" (Longmans, Green & Co., London).

Fossils.

By F. A. BATHER, M.A., F.G.S.

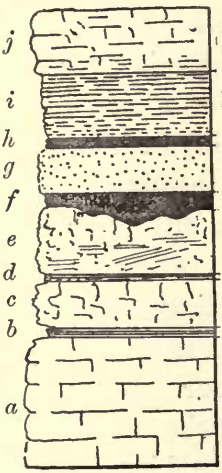
[Note.—*As so many friends write and ask me how they should begin the study of Fossils, I have cast this chapter into the form of an answer to such an one, thus venturing to treat the readers of this book as my friends.*]

Fossils.

I AM very glad to hear that you intend to take up the study of fossils. It is one that you will be able to carry on at very little expense to yourself; in making your collection you will be taken into the open air, in all parts of the country; and you will always have the satisfaction of knowing that, while learning about forms of life, you are not in any way taking it. There is a good deal of excitement in shooting birds, or in catching butterflies; but, after all, there is often quite as much in discovering rare fossils in a quarry, or in extracting some beautiful though fragile specimen from the hard rock. Great fun we used to have in our school-days in those old chalk pits near Winchester, hammering out the shells and the sea-urchins, and seeing who could make the biggest bag. Then, too, there is always a sense of mystery about a fossil. It is wonderful to clear away the clay or the marl from some coiled Ammonite, and to think of the myriads of years that it has lain there, and what changes have taken place since the day when it swam about

in some strange sea, where now are hills, and woods, and houses. And yours are the first human eyes that have ever beheld it, and you have the privilege of bringing it again to the light of day, and of learning the story that it has to tell.

Very strange indeed are some of the stories that are taught us by the fossils. Here, for instance, is a rough diagrammatic sketch of the rocks shown in a certain quarry. At the base is a bed of hard limestone (*a*), with shells, corals, and such animals as now inhabit the depths of the sea. Above it come seams of clay (*b*, *d*) and more rubbly and sandy limestone (*c*, *e*), with some sea-urchins and shells of a sort that live nearer the shore. The upper surface of these beds is uneven, and is filled with black earthy matter (*f*), containing the remains of plants and roots of trees, evidence of an old land surface. Then come sand and marl (*g*, *i*), with an occasional band of earthy matter (*h*), and containing freshwater shells, insects, and, perhaps, very rarely the jaw of some small mammal,



showing that a river had begun to flow over the former forest. This is followed by a limestone (*j*) with shells of a more saltwater habit, which seem to prove that this region must have once more sunk beneath the sea, before being raised up to make the land on which we now walk.

But, as you have already determined to go in for fossils, there is no need to dwell on the delights of the study. I may, however, point out that your specimens will give you plenty to do in the winter days, when it is no longer so easy to go out collecting. Then you will have to clear them out from the bits of rock still attached to them; and then, with the help of books and public collections, you must try and find out what their names are, and not that alone, but what kind of animals they were when alive, and the relation they bear to those now living in our seas and on our shores.

For you must never forget that fossils are not mere figured bits of stone, but that they really are the remains of living things, only to be properly understood by a comparison with the animals and plants that now exist. Very different in outward appearance they often are, it is true; but you will find, on close examination, that they can generally be referred without much difficulty to some of the now-living classes

of the Animal or Vegetable Kingdoms. I should, therefore, recommend you, when you have got some fossil that you wish to understand, to get hold of some living animal like it, and to examine that carefully, dissecting it and drawing it. When you have learnt the names of the parts of the recent animal you will then better understand the meaning of your fossil and the descriptions of it that are given in books. Of course, the fossils that you will be most likely to find are those of the smaller sea-animals, such as cockles, oysters, cuttle-fish, lamp-shells or Brachiopods, sea-urchins, corals, and crabs. Take advantage, then, of your next visit to the sea-side to catch some of these, and, if possible, to observe their habits.

You will soon find that the different quarries you go to, in different parts of the country, furnish different sorts of fossils, and this will lead you on to the study of geology. You will see that the rocks are very different, and that different rocks contain different fossils. And, if you have good opportunities and good eyes, you will easily observe that the order in which these rocks and fossils are placed one above the other is always the same. For instance, there are two large beds of clay in England, the Oxford clay and the Kimeridge clay, which are

very much alike in outward appearance. But they contain different species of fossil animals, and between them are found beds of a rough limestone, full of corals and sea-urchins, and known as Corallian. Now the Oxford Clay, with its particular fossils, is always found to lie beneath the Corallian, while the Kimeridge Clay, with its particular fossils, always lies above it. This order is invariable, so that, alike as the clays are, there need never be any danger of confusing them. It is in this way that, by the fossils, we are able to trace the same bed of rock over large tracts of country. Therefore, it is very important that you should always label each of your specimens very carefully, not only with the exact locality, but with the exact bed of rock in the quarry in which you found it. It is a good plan to make a drawing or section of the rocks in the quarry in your note-book, like the one given on page 126, and to number or letter the various beds of clay, limestone, etc. Then, though you may not know the *name* of the bed in which your fossil was found, you can at least denote it quite accurately on your label. At the same time add a reference to the date, and to the page of your note-book, thus:—

"Chilmark Quarry, E. side, bed 6, p. 33,
August 9th, 1893."

At any future time you can find out the name of the fossil; but if the information as to locality and horizon is once lost or forgotten, it can never, with certainty, be recovered again. In such a case, the best thing to do with your fossil would be to smash it up with the hammer.

You ask me about tools. A hammer and cold chisel are almost always necessary. The exact shape and size of the hammer varies with the hardness of the rock. It is also useful to carry a small pocket hammer for roughly trimming specimens in the field. For clays and sand a large strong knife is as good as anything. Always carry a measuring tape, so as to make your sections and sketches accurate. It is useful to have inches marked on the handle of the hammer. Plenty of paper, and a few old match-boxes, with a little cotton wool, should be taken. Grass, soil, sand, or a dab of clay, will often serve to protect a delicate specimen. It is best to write your labels on separate slips of white paper, and to wrap them up with the fossil. The best way of carrying fossils is in stout canvas bags, each with two rings, slung on a broad leather strap. You should also take samples of clays and marls in a tin box, so as to wash them for the smaller forms of life.

The method to be adopted in cleaning fossils

varies very much with the kind of rock in which they occur. Some can be easily cleaned by soaking in water and brushing with a hard brush. Others would fall to pieces under such treatment, while others would be in no way affected by it. For both the latter kinds the best instrument to use is a needle fixed in a handle. Fossils should never be scraped, or scratched, or cleaned with acid; but the rock should be flaked away gradually by simple pressure with the needle. Brushing with a dry brush is sometimes useful.

When your fossils are cleaned and labelled neatly, you must try to find out their names. First of all determine in what class of the Animal Kingdom they should be placed, then try to find out from some good text-book of zoology to what Order and Family they belong. Such bits of knowledge are far more useful than the mere Latin name, and at the same time they will help you more easily to find out the latter. This you will best do by going either to your local museum, or to one of the large museums, such as the Natural History Branch of the British Museum, in Cromwell Road, or the Museum of Practical Geology, in Jermyn Street, and comparing it with the exhibited specimens. Try to find out things

for yourself; it is of no use getting a string of names from other people. Draw your specimens carefully; this will make you note points that might otherwise escape you, and will also help you to understand the drawings in books.

As to books :—You can learn something about Geology from the "Primer of Geology," by Sir A. Geikie (Macmillan, 1s.); and may then go on to the "Classbook," by the same Author. Geikie's "Field Geology" is also very good, but perhaps you will find the one by Penning and Jukes Browne (Bailliere, Tindal & Cox) more useful, as it will tell you more about fossils and how to collect them. "Aids in Practical Geology," by Grenville Cole (Griffin, 2nd edit., 1893, 8s. 6d.), is another useful book of a similar nature. Get the Geological Survey map of your district from any mapseller, and try to understand it, with the help of one of the above-mentioned books, and of the Memoir sold to accompany the map.

There are very few good books that will tell you about living, as well as fossil animals. "Our Common British Fossils, and Where to Find Them," by J. E. Taylor (Chatto & Windus, 7s. 6d.), is useful for beginners. Mantell's "Medals of Creation," which can easily be

picked up, second-hand, is a charming book, though a little old-fashioned. To help you in dissecting animals, begin with Huxley and Martin's "Elementary Biology," enlarged by Howes and Scott (Macmillan, 10s. 6d).

Animals for examination may be got from Sinel & Hornell, Biological Laboratory, Jersey; or from the Marine Biological Laboratory, Citadel Hill, Plymouth.

Hammers, chisels, and such necessary articles, may be bought of F. H. Butler, 158, Brompton Road, S.W., of J. R. Gregory, 88, Charlotte Street, Fitzroy Square, and of the Publishers of this Handbook.

If you live in or near London, you might find it useful to join the Geologists' Association, of which a prospectus may be obtained from the Secretary of the Association, University College, Gower Street.

How to Observe without Destroying.

By EDITH CARRINGTON.

Author of "Workers without Wage."

How to Observe Without Destroying.

"He, out of nothing, made sky, earth and sea,
And all that in them is—man, beast, bird, fish,
Down to this insect on the parapet.
Look how the marvel of a minim crawls!"
(Robert Browning.)

THERE is a venerable proverb, familiar to us from our nursery reminiscences—"If you cannot make it, you ought not to break it." Like many old sayings of the kind, it contains a valuable truth, namely, that we should hesitate to destroy that which no power of ours can replace, especially in the case of life, which is the gift of the great Creator.

There is a risk in the present age, when so strong and rightful a thirst is felt for cultivation of the intellect, that we should gratify the longing for brain development at the expense of hardening the heart and injuring the moral sense. Herein lies a real danger for the young naturalist.

Every act of wanton tyranny over a defenceless living creature, every deed of heedless

destruction, however trifling, leaves the doer of it less good and noble than he was before, and more prone to mercilessness.

In the few remarks on studying Nature which I am about to make, I shall therefore be very careful to suggest that the best mode of observation consists in watching wild creatures in a living state, and in their own homes, and that such imprisonment as absolutely *must* be inflicted for purposes of study—artistic or otherwise—should be as brief as possible in duration, and as much alleviated as circumstances will permit; remembering always that *captivity is a punishment.*

The true lover of Nature ought to walk amid the fields and woods as if he were passing through a sacred temple, in which he is a worshipper at the same shrine before which every living creature is all day long offering its incense of praise, by sweet warblings, and a thousand incoherent voices, none without significance to the Divine ear, but which he alone can join with articulate words—moulding into speech what they fain would say.

"Man is the world's high priest; he doth present
The sacrifice for all, while they below
Unto the service mutter an assent,
Such as springs use that fall and winds that blow."

(Herbert.)

He ought not to go forth as a destroyer, but as a reverent observer, and then he will find that his forbearance will win a way for him into the very heart of Nature.

There is a certain way of approaching wild creatures and their haunts—a peculiar mixture of familiarity with gentleness, a manner without hurry or nervousness—which they seem to understand and appreciate. The step must be soft, but firm ; yet with nothing stealthy about it. Once disarm the wild bird, the squirrel, the field-mouse, or the hedgehog of the idea that you mean to chase or hunt it, and it will allow you to come within the circle of familiar friendship—so long as you do not press that friendship too far at first ; and the fascinating charm of being able to draw near enough to watch these free denizens of the open country, without treachery on your own part or terror on theirs, is perfectly entrancing—worth any quantity of the enforced tameness wrung from them by caging.

Even the wasp—that much maligned insect—will allow a near inspection of her domestic economy, provided that no interruption to business be offered. This summer I watched a nest, putting my face close to the hole at which a stream of wasps were passing in and out ; my

head was in their way, but they flew round it, and not one, of the many thousands, offered me any injury. I was able to admire the marvellous manner in which the two processions of wasps—one going down the hole and the other coming up—contrived to time their exits and their entrances, without ever jostling each other, or quarrelling, although the entrance was so narrow as to admit only one at a time. I was also able to observe of what the food consisted which they brought for the young below: Pieces of caterpillars, halves of flies, and many other like morsels. So beguiling was the scene that, oblivious of time, I came home shamefully late for dinner! I recommend the study, which I was obliged to break off, to anyone who wishes to spend an hour profitably, with the assurance that nothing need be feared. Much hitherto unknown history of bees and wasps might thus be tabulated.

One point struck me above all others: Two wasps never met in the passage. How was this arranged? Is it possible that they timed themselves—or how could the up-coming wasp tell when to start, so as not to encounter a down-coming friend? I throw out these points as questions for solution.

I once cultivated the acquaintance of a water-

rat, which grew to know me perfectly well. I sat on a flat stone which jutted out over the brink of a stream, and waited, while reading my book, till I heard him stirring among the reeds almost beneath my feet, and crunching the greenest with his sharp teeth; I then threw a bit of apple, or some trifle of that sort, into the water, which he would come out and fetch. Generally he took it into his hole to eat, or he would hide in the reeds and nibble the treat. I secured an opportunity now and then of prying into his ways. He washed his face like a cat, and a water-lily leaf sufficed him as an island.

In the same manner, I once had a field-mouse as a "chum" for my lonely hours. This little creature had made a sort of tunnel, or "run," in the grass on a down, which led to its hole, and I used to scatter grains of wheat, or even a whole ear, in this pathway. He would steal out timidly to fetch the food, and became so bold at last as not to mind my being close by. I even fancied once or twice, when my mousie came home from a ramble and found nothing there, that his bright beady eyes peeped from the grass stems with a waiting and reproachful glance.

Birds may easily be tamed out of doors by the same method, by teaching them to become

accustomed to the human presence by degrees, and to associate it with small acts of kindness in the way of treats. Birds are, many of them, really fond of one's company, and will often accompany a traveller for long distances, flying along the hedge and singing, as if to enliven the way. If this overture on the part of a bird be met, and the little winged friend not frightened, it will become yet more bold. Really precious facts may be ascertained in these ways; little scenes in the drama of animal life, such as human eyes never rested on before, may be recorded. The note-book should be a constant companion, and a diary kept, in which every such fact should daily be noted down.

Every naturalist should carry a small pocket lens, a good field-glass, and, if possible, a portable telescope. With the latter, if it be steadied against a wall or tree, or on a forked stick driven into the ground, the shyest birds may be watched from afar—their kinds, colours and mode of feeding ascertained, and every detail of their domestic economy laid bare. For those who can manage it, photography affords a rapid method of carrying home an image of what is seen during a stroll. Collections of birds' nests may be made without cruelty, by taking the deserted abode when the brood is

reared. Every nest found should be revisited from time to time, care being taken not to go too often, not to alarm the parent birds by too long a stay, and not to expose their secret to the gaze of others. A great ornithologist (Mr. Hudson) has lately made public a valuable hint as to the practice of robbing birds' nests for the purpose of egg collecting. He strongly condemns the habit, and suggests that instead, artificial eggs should be made. This, he says, will give all the excitement of nest-finding, without cruel destruction—will leave the innocent pleasure free from blame.

He leaves the process of egg-making for someone else to elaborate, and, after some attention bestowed on the subject, I venture to give a system which will, I think, be found a good one, though in my turn I place it for improvement in the hands of anyone who can perfect it.

I propose then, for a material, ordinary modelling wax, which can be procured at any artist's shop—say Rowney's, in Rathbone Place. This material is made in a variety of colours, but white wax, to be coloured afterwards, would in most cases be best. The wax needs only to be placed in warm water till it is soft, and it can then be cleanly and evenly

worked into any shape. A little pulverised chalk amalgamated before the wax hardens, will give a surface very like that of a real egg, only not polished, and will fit it to receive the colour. For this, oil paint, such as artists use, would do for those who are at all skilful in handling a brush; but, with powder colours, or even coloured crayons, rubbed in with the finger or with a "stump," a child could produce a smooth and uniformly covered surface as a ground tint. The spots, specks, and streaks should be painted with a fine sable brush, or might with care be managed with a crow-quill. The whole, when dry, should receive a coating of some diluted varnish—say copal, or "white spirit varnish;" if this be thought too bright, it must be thinned to suit requirements, with turpentine. It may be needful, in the case of some eggs, to varnish and dry the ground tint before laying on the markings.

The egg-maker may compare his finished work with a real egg in any of the nests which he has found, or at a museum. He must prepare beforehand, a rough drawing (if possible, a coloured sketch) of the egg from nature, as a guide for size, shape, &c. Perfection so great may be arrived at after a few trials, that the model may deceive the eye, when the false egg

is placed for a moment in a nest beside the true one—its pattern. The student's collection will thus be a work representing art and industry on his part, instead of pitiless thievery from the tiny feathered parents, who take such pride in their home. The preparation of the eggs will give in-door occupation, always a great want during a large part of the year.

If it be desired to steady the waxen egg for painting, an ordinary hat-pin with a large head may easily be fixed in a hole bored for the purpose in a small block of wood. The point may then be forced far enough into the egg to hold it secure, and the pin-prick can be obliterated when all is done. No collection of eggs is so pretty as that in which each kind is shown in the appropriate nest, and by taking the nests when done with, this arrangement may be made; but *nest-making* might, by adroit fingers, follow egg-making, and nothing could teach the secrets of bird architecture better than an attempt in that direction.

With regard to butterflies and moths, they afford exquisite artistic studies, and may be drawn and painted while alive, if bred from the egg or taken in the chrysalis state and allowed to issue. A quiescent condition usually follows the emergence of the insect from its birth-sleep,

which is of peculiar value to the designer. Drawings of these creatures, while they are thus strengthening themselves for flight, are easily procured, and the beautiful beings can then be let go to adorn the world.

A good book on the subject will give all details as to the various species, their times of appearance, life history, &c. There is none better than Edward Newman's *Illustrated Natural History of British Moths and Butterflies* (published by Hardwicke).

The ordinary breeding cages can be obtained at Cook's, in Museum Street, Bloomsbury, at prices varying from ninepence to five shillings, according to size ; but any ingenious person can construct one. The top and sides are of glass, all but one, which forms the door, and is made of perforated zinc for purposes of ventilation. A deep bottom holds earth or sawdust, in which the caterpillar may choose to bury itself, and takes the little pots of water for the plants on which it feeds, which must be kept as fresh as possible, and are, invariably, those on or near which it is found. Drawings should be made of the caterpillar, as well as of the chrysalis and perfect insect.

Water creatures, when brought home for a time, in order that any special habit may be

watched, or a drawing made, should be kept *out of doors.*

Most of the failures in the form of aquaria are due to the fact that water cannot be kept for long in a condition suitable to healthy life within an ordinary living room, however carefully it is managed. There is nothing better by way of vessel than a few small bell-glasses, turned upside down in pots of earth, and arranged in a row on a common window-ledge, after the mode of a window-box. Being of manageable size, these may easily be lifted into the room when wanted; hence the superiority of many small glasses over one large aquarium—besides the necessity of dividing creatures hostile to each other. A rim of perforated zinc should be fixed around the top of each glass, by means of putty, wire, or string, rising half-an-inch or so above the edge, so that any overflow from rain would run away without letting the creatures be washed out. The side next to the light should be protected by a board, to prevent excessive illumination of the water—which the lidless eyes of these dwellers in the liquid element are not framed to endure. Water-crowfoot should be supplied, and some aquatic snails put in, as well as sand-stones or shells to form a refuge. Almost any water creatures,

except fish, may be retained, without a trace of cruelty, for a short time in this way; but food must be supplied to the voracious, such as the caddis, and all water-beetles. This is best done by sweeping a net through pond water once or twice, and bringing home every day a supply of the small larvae, multitudes of which are furnished, it would seem, by Nature, to be the natural sustenance of other tribes, so prolific is she in bringing them forth.

The eggs of the common newt, which the mother wraps carefully up in the branches of some water-weed with her little hands, are exquisite objects to watch through their development. These eggs should in no case be removed from the bits of weed to which they are found adhering (generally crowfoot), but the weed should be cut off, moored to a stone, and sunk in the bell-glass. The baby newts emerge in a few days, delicate and translucent as rainbow-glass, and most interesting. The young newt, with its irridescent colours, slim form and gem-like eyes, ranks among the loveliest children of the waters, whether in its early fish-seeming state, or later, while it is transforming into a creature with limbs frail and fragile enough to belong to fairyland. It is a purely vegetable feeder at first, but requires animal

food before long, and then it is best to return it at once to the pond, before it pines. Duckweed contains vast quantities of minute living organisms, on which both newt, toad and frog tadpoles live. (The toad tadpole is covered with a sprinkling of minute gold specks; the frog tadpole is altogether dark.) The eggs of the latter are found floating on the the top of the water, and may be treated exactly as the former to begin with; but as they grow into their latter stages they require a larger diet, and to find it for themselves. They also begin to desire another life, and it becomes unmerciful to coerce them. If it be really needful, however, to retain larger tadpoles for a while longer, they should be given a landing-stage, and fed every day on worms or meat. A good-sized thickly-cut raw bacon rind, tied to a string, so that it may be easily withdrawn, and not sully the water, will afford a luxurious feast for a long time, but any raw meat will do. An inexhaustible store of objects for the microscope—*Animalculæ* of many kinds—will be afforded by the bell-glasses, after they have been exposed for a day or two to the sun's rays.

But, after we have ascertained our facts, made our picture, or learnt our lesson, the least that we can do is to set at liberty the little captives

who have afforded us, at the cost of some discomfort to themselves, so much pleasant instruction. Our science will do us twice the good if we have not stained its lore by "sorrow of the meanest thing that feels."

Tennyson understood how great was the temptation to learn at any cost, and how great was the danger of callousness towards the lower creatures involved, when he wrote his beautiful verse :—

> "Let knowledge grow from more to more,
> But more of reverence in us dwell;
> That mind and soul, according well,
> May make one music as before."

The Microscope, and how to Mount Microscopic Objects.

By the Rev. THEODORE WOOD, F.E.S.

The Microscope, and How to Mount Microscopic Objects.

MICROSCOPES, it need hardly be said, are of all sorts and sizes. They vary in price from the costly instrument upon which a hundred guineas, or even more, may be expended, to that which may be obtained for a few shillings. The former is within the reach of but few, and, practically speaking, is of use only to specialists. But almost every lover of Nature can afford to purchase the latter, and much really good work can be done by its aid. In the following remarks, therefore, I shall leave the higher priced instruments out of the question, and shall assume that my readers have provided themselves with a microscope costing not more than one guinea at the most.

Roughly speaking, such a microscope consists of six principal parts. There is (1) the *Eye-piece*, which magnifies, not the object itself, but its image. This slides up and down in (2) the *Barrel*, which can be raised or lowered by means of a wheel, in order that the proper focus

may be obtained. Next comes (3) the *Object-glass* or *Objective*, by which the object itself is magnified. This, in the cheaper microscopes, usually consists of either two or three lenses, screwing upon one another, which can be used together or separately, If a high magnifying power is required, all three are employed; but for ordinary work it is best to use one only, and that the least powerful of the three. The object to be examined is placed upon (4) the *Stage.* This is a small platform of metal, perforated in the centre by a hole sufficiently large to permit of the transmission of light from below. The *Condenser* (5), is a lens, so fastened to the stage, or to the frame of the instrument, as to permit of motion in any direction, by means of which light from above can be concentrated upon opaque objects; while (6) the *Mirror*, which is also movable, throws light from below *through* the object when it happens to be transparent.

Let us now suppose that an opaque object, such as the surface of a leaf, or a butterfly's wing, is to be examined.

Place it upon the stage—first laying it, if necessary, upon a slip of glass—and then arrange the condenser in such a position that a strong light is thrown upon that part of the

object which lies just beneath the object-glass. Then, applying the eye to the eye-piece, slowly turn the wheel until the right focus is obtained. If only one objective is in use, this operation is a very simple one; but with a higher power it is not very easy to get a small object just in the field of vision. After a careful examination, alter the position of the condenser in such a way that the light comes, not from above, but from the side. This plan will often bring out points of structure which would otherwise be overlooked. Finally, if the object be a very minute one, add one or both of the additional object-glasses, and examine it again; remembering, of course, that the focus must be altered in accordance with the increased magnifying power.

With a transparent object, such as the wing of a bee or wasp, or a delicate section of vegetable fibres, all that is necessary is so to arrange the mirror that light is thrown upwards through the hole in the stage into the barrel of the instrument.

The eyes should be used alternately. It is a great temptation always to use the same eye, which after a short time gains both strength and discriminating capability. But to do so is certain, sooner or later, to result in strain, and perhaps even in serious injury.

The eye not in use should not be closed. Just at first it will not be found very easy to keep it open, or, when this difficulty has been overcome, to concentrate the attention upon the objects seen by the other eye alone. This, however, is merely a matter of practice, and ought not to trouble the beginner for more than a very few days.

Light is a very important consideration. This must not be too brilliant, or it will only dazzle and tire the eye. Direct sunlight should, of course, be avoided; but, on the other hand, the light afforded by a clear blue sky will be insufficient, and a cloudy day is better than a brilliantly fine one. On a very bright, sunny morning it is a good plan to cover the window with a sheet of white paper. When artificial light is employed, let it be that of an oil lamp, or else of an argand gas burner, which can be brought quite close to the instrument. Candle-light is quite useless, and indeed injurious, as it cannot be prevented from flickering, and every flicker is magnified by the microscope in quite a distressing degree. A good moderator lamp is, perhaps, the best; and a dark shade should be provided, in order to prevent its direct rays from reaching the eyes.

The lenses of the instrument must always be

kept perfectly clean, and free from dust. From time to time they should be wiped, not with a pocket-handkerchief, but with a small piece of wash-leather, kept specially for that purpose and none other. The operation must be very carefully performed, or the glass will be scratched. If dust should collect round the *edges* of a lens, as generally happens sooner or latter, it can easily be removed by means of a camel's hair brush. Moisture, too, is apt to condense upon the lenses if the instrument is brought from a cold room into a warm one, and it is, therefore, advisable to bring the microscope into the room in which it is to be used some little time before it is actually employed. For the same reason, the lenses should never be touched with the bare fingers, the exhalations from the skin being quite sufficient to dim their brightness.

Now as to the objects to be examined. These, of course, are legion, and can be obtained almost everywhere in bewildering profusion. Petals of flowers, leaves of trees, sections of bark or of the stems of plants, the hairs of different animals, the various parts of the bodies of insects and other small creatures, pollen, seeds, spores, minute fungi, the crystals of various chemical substances—there is no limit

to the material at the command of the ardent microscopist. It is not a bad plan to work at a single subject at a time, and thoroughly to exhaust it before proceeding to another. A butterfly, for example, will provide the following objects, all of which are well deserving of careful study:— Scales from upper and lower surfaces of wings (these are often very different); wing membrane; section of wing nervures; hook uniting upper and lower wings during flight; antennæ, or horns; compound eyes; simple eyes; feelers; section of trunk; hairs of thorax and body; joints of feet—to say nothing of the various details of internal structure, which can be dissected out without very much difficulty (stout needles ground down upon a hone make capital instruments for this purpose). The breathing holes and breathing tubes are best seen in a smooth-skinned caterpillar, which will, also, furnish objects of great interest in the jaws (two pairs), the true legs, and the "false feet," or claspers, which are also used for locomotion. These different parts of the bodily structure, too, vary to an almost infinite degree in different insects; so that even one small group of this one class of animals will provide an enthusiast with ample occupation for the leisure hours of a long life-time.

Even living creatures can be obtained and examined. The enquirer can make acquaintance, for example, with the inhabitants of a drop of water. All that he need do is to moisten a glass slide with water taken from a stagnant pool, and bring one of the higher object-glasses to bear upon it. He will then discover that it is literally swarming with minute organisms, both animal and vegetable; many of them of most singular structure, some of grotesque appearance, but all affording much of absorbing interest, much to wonder at, and not a little to admire. Whatever branch of microscopy the student may take up, indeed, will amply repay him for the time and trouble expended upon it: and more and more will he find cause to marvel at the wonders of creation, and the infinite variety and complexity of Nature's work.

Before he has been working with his instrument for very long, the student of microscopy will feel the desirability of mounting, for permanent preservation, some of the more interesting objects which he examines. In its simpler forms this is not a very difficult process, and after a little practice one ought easily to be able to mount twenty objects or more in the course of a morning's work.

For ordinary mounting, the necessary para-

phernalia will cost about five shillings, consisting of (1) a small spirit-lamp; (2) a supply of glass strips (technically called "slides"), measuring 3 in. × 1 in., and with the edges carefully rounded; (3) a number of small squares of very thin glass, for covering the objects; (4) a small bottle of Canada balsam; (5) a sheet or two of ornamental paper; (6) a flat plate of brass or copper, about 6 in. × 3 in.; and (7) a pair of delicate forceps. Besides these you will want a needle or two, forced into the ends of the handles of camel's hair pencils for about half their length; a fine pair of scissors; a solution of soda and another of caustic potash; and a few small leaden weights—small bullets cut in half will do admirably.

There are three principal methods of mounting, namely, "dry," "balsam," and "cell." Let me say a few words about each in turn.

I. Dry mounting. This is by far the simplest, and can be used for all objects which it is not necessary to keep from contact with the air. For this the spirit-lamp will not be necessary. Take a slide, and rinse it first in the solution of soda, so as to get rid of all suspicion of grease, and then in hot water, taking care not to touch it with the hand. When quite dry, mark the exact centre by means of a small dot of ink upon

the lower surface, and then lay your object, very carefully, upon the upper surface, just over the dot. Having arranged it in position by means of a needle, lay one of the thin glass squares upon it. Then take a piece of ornamental paper, two inches long by seven-eighths of an inch wide, cut out a circular hole in the centre (by means of a punch, if possible), cover its lower surface evenly and not too thickly with paste, and then lay it upon the slide in such a manner that the object appears just in the centre of the circular hole. Press the paper down gently, and leave it to dry, looking at it once or twice to see that it is not starting up from the glass. Finally, fasten a small gummed label (a chemist will supply you with hundreds for a few pence) to one end of the slide, and write the name of the object and the date of preparation upon it.

If economy is desirable, two objects can be mounted upon one slide, one at either end, with the label in the middle.

II. Mounting in balsam requires more care, but is necessary for such objects as will not lie quite flat and evenly upon the slide. Light the spirit-lamp, place a pile of books of suitable height on either side, and lay the brass plate across between them, so that it can be moderately heated by the

flame. Wash the slides as for dry mounting, and place two or three of them on the brass plate. Then melt the balsam. When thoroughly melted, take a small drop by means of a glass rod, and lay it on the exact centre of the topmost slide. Work it about with a needle until it is quite liquid, taking care that no air-bubbles remain in it, and then lay your object just in the middle. Let it lie for a few moments, and then cover it with a still smaller drop of balsam, removing air-bubbles as before. Now take a glass square (which must be perfectly clean and dry), and press it down very carefully and *evenly* upon the balsam. If it is held ever so little to one side, the objetc will slip out of position. Finally, remove the slide to a cool place, lay one of your leaden weights upon the glass square, and leave it for a week to harden, taking care that no dust shall fall upon it.

When perfectly dry, remove the balsam which has oozed out beyond the edges of the square, by means of the heated blade of an old knife. This must be done very quickly and carefully, or the balsam beneath the square will melt. Finally, cover with ornamental paper, and label as in the case of a dry mount, and your slide is complete.

Many objects, before they can be treated in

this way, must be steeped for twelve hours at least in the solution of caustic potash, so as to remove all traces of fat. This will be necessary, for instance, with all the internal parts of insect structure, and even with the membrane of the wings.

III. Cell-mounting is difficult, and unsatisfactory unless very well executed. It is chiefly useful for dissections, showing organs, &c., *in sitû*. It is best to buy the cells ready made: but they can be manufactured by painting a circle in the centre of the slide with cement or varnish, and adding layer to layer until it is sufficiently deep. When the cell is finished, and quite dry, partly fill it with spirit, introduce the preparation, remove any air-bubbles, and then fill up almost to overflowing. Then lay a circular glass cover of suitable size upon the top, and leave the slide for two or three days, until the object has quite settled into place.

In order to finish off, lift the cover, paint the top of the cell with thin cement, fill up once more with spirit, to replace any loss by evaporation, and lay on the cover once more, this time pressing it down upon the cement, and keeping it in place by a leaden weight. Remove any of the spirit which has oozed out round the edges by means of a piece of blotting-paper, and, when

the cement is quite dry, render the cell air-tight by painting the edges two or three times with asphalte varnish. Label as before.

If preferred, distilled water in which a very little corrosive sublimate has been dissolved, glycerine, or Deane's gelatine may be used instead of spirit; and all three have the advantage of being far less liable to evaporation.

Microscopic slides should never be laid flat, and are best kept in boxes, fitted with a number of grooves which hold the ends securely.

Teaching Natural Science.

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Teaching Natural Science.

FIRST of all it may, perhaps, be as well for me to remind parents and teachers of the wonderful faculty children possess for imitating their elders; what their elders do, it is certain the children will try to do; and, in teaching Natural History, it will be well to let this fact be a guiding principle. Enthusiasm on your part will result in, at least, interest on theirs; your own dislikes and pet aversions must be battled with, and frogs, toads, newts, spiders, beetles, snails, or whatever it may be, must be made welcome, and thought worthy of your attention and kindness. Children are not, as a rule, afraid of any of these things, and are only too ready to seize upon them and make them wretched, by attempting to keep them as pets. It is this innate love for live creatures that should make teaching Natural History a pleasure to everybody. Children quickly get enthusiastic, and just as easily lose their interest and pleasure, especially where their elders do likewise; but where there is real, unflagging interest

and enthusiasm on the part of the teacher, wonderful work can be done. When the children once feel in earnest over the subject, the teacher has plenty to do, for a perfect plague of every kind of creature seems to set in, and the difficulty then is, how to dispose of them without hurting anyone's feelings. Unlimited spiders and innumerable small frogs, are apt to become a nuisance, especially as it is most inadvisable to encourage the universal rage for indiscriminate collecting. It is not at all necessary to "collect" in order to learn Natural History. Children should be allowed to bring home objects to examine or to paint, under the supervision of their teachers, but in these days of cheap text-books, by our best scientists, subjects can be studied without the cruel habit of "killing" at every available opportunity.

Out-door collecting for examination at home.

The plan I strongly advise all teachers to adopt is, that instead of killing the creature, it should be imprisoned for a short time, and as carefully as possible drawn or painted; this may be easily done without injuring it. In fact, children should be encouraged to bring things home, on the understanding that no creature should suffer in consequence. A short imprisonment is all that is necessary, in order to examine or draw any object found by the children. They

should not be allowed to carry things home in their hot little hands, it is perfect misery to the specimen to be so roughly treated, but children do not think of this; you must, therefore, make a very strict rule that everything is to be brought home in boxes. Small tin boxes, ventilated, are the best to use for carrying purposes; the cool tin, and a few small dock leaves or blades of grass, will make a good temporary home for most creatures. It will also be found necessary to limit the children as to the number they may bring home. Keep to one creature at a time as much as possible, and don't admit other "beasties" till this one is exhausted. If you are studying snails, you will find plenty of work for a good many days, and the same with other things, so do not hurry over them, nor allow the children to do so either. When at home, place the object to be examined under a clear thin tumbler, and let the children each make their own notes and remarks, until all is carefully described; then examine the text-book, and compare notes and illustrations, after which the object should be set free. Let each child try to draw or paint it, and do not despair if, for some time, the pictures seem very badly done; in the end you will succeed, and the children will learn far more about the newt or beetle, by

trying to take its portrait, than by saying "Oh, it's only a newt," or "only a beetle," and letting it go with merely a passing glance.

The children should be early taught to take careful observation of the trees as each season comes round. Teach them to notice the buds, twigs, and contour during the winter months; then, as the spring advances, they should note each change as it takes place, from the bursting buds, to the trees in full leaf and beauty. The twigs may easily be mastered in the following way: Procure the twigs, and catkins, if possible, of all the common trees around you; carefully tack them on to small sheets of white cardboard, size $6\frac{1}{2}$ inches by $12\frac{1}{2}$ inches. Write the name of the tree clearly underneath, and hang the cards up, with a coloured ribbon, on the school-room wall; they are most interesting. If elastic loops are used, fresh twigs may be inserted as often as necessary. The winter may be followed by the spring buds, and, afterwards, by the sprays of leaves. This plan has been tried with great success on a class of ten children (House of Education Practising School); they are now the keenest observers of trees, and can tell them quite readily at a glance. Of their own accord they all name and mount small twigs and catkins, writing the

names in very large letters underneath; they are also doing the seed-vessels of various plants. Once a week they go for a walk with their teachers, to search for specimens, and they bring their treasures home with the greatest pride and delight.

A small aquarium will afford much pleasure if well managed. Nothing need suffer if you keep the things for a short time only, and then return them to their native pond. In this way you could make acquaintance with specimens of all the denizens of the ponds about you.

Nature note-books.

Every child, or what is perhaps better, every family, should keep a Nature Note book, if you wish for really good work. You will find that the children will take the most unflagging interest in it; they will carefully search in all directions, and discover many kinds of things that they will wish to enter. The book should be written up most carefully each evening; notes should be made on anything the children have specially remarked during the day. The elder children will like to do this for themselves, in note-books of their own. Let them each have a strongly-bound exercise book of about 150 pages; but where there are many little children, a book for the whole family is by far the best plan. One book, well and care-

fully kept, will be a great pleasure. Where the father has time to help, the note-book should be his special province; a short time every evening would suffice for the actual writing. If the father can draw it will be delightful, and this would afford the opportunity of getting and keeping in touch with the children's work, which many fathers desire. In order to make the note-book a complete success, it should be illustrated by pictures drawn from nature. I have already mentioned that this should be done, no matter how badly at first, in order to learn to observe what each creature is really like. But, at the same time, it should be done with the definite object of providing illustrations to accompany the notes in the note-book. Twigs are capital things to start with, and are quite easy to do; pin them on to a piece of white paper, and stand them up in front of you, then carefully copy them in water colour, and you will soon make a fairly accurate drawing. For the encouragement of those who think that they cannot draw, and so could not possibly keep a "Nature Note-book," may I say that, after much experience, I have found that many who said, at first, that they "never could, and never should be able to draw," after trying for a comparatively short time to draw twigs,

began to copy them beautifully, and are now doing nice work for their books, though they utterly failed in ordinary freehand drawing from the flat copy. The note-book should contain short accounts, dictated by the children to the father or mother, of the definite Natural History lessons that they have received from their teacher; also a dated Naturalist Calendar,* and short notes on the weather This will give plenty of work, but not too much if done in an orderly and systematic manner. A separate book should be kept for each year.

SPECIMEN PAGE OF A NATURE NOTE-BOOK FOR 1893.

Daily Notes.

Oct. 16.—We noticed to-day that a very handsome spider had begun to make its nest on the bark of an oak tree. It had already covered its eggs with a quantity of web when we first found it, and on looking carefully we saw the way it did this. Keeping its head towards the centre, it worked round and round a perfect circle; as it alternately raised and lowered its body, it pressed out a little silk, and with its last pair of legs took hold of it, and pressed the silk down in a number of tiny soft loops. It was working hard all the time we were there. We came back through the wood, and on the way back examined some viviparous

* See White, of Selborne.

grass, *i.e.*, grass with its seed sprouting while still on the plant. Also we saw that the wild cherry trees were beginning to lose their crimson leaves. They are the first leaves we have seen fall this year. The larches are turning yellow. We found a wild rose in flower.

Oct. 17.—Went again to see how the spider was getting on. The eggs are all covered with a thick mass of yellow silk, and the spider is spread out on the top. Came home by the waterfall, and found the Filmy-fern.

Oct. 18.—Went again to see the spider, and found that eggs, silk, spider, all had gone. We looked carefully in great dismay, and found no trace of anything, when all at once, to our great delight, we saw the reason why. The spider had most beautifully and carefully covered up the whole nest with tiny scraps of lichen, which completely disguised it, and it looked just like a little knob on the bark. The spider herself had gone.

Specimen List from a Nature Note-Book.

Flower List for October, 1893.

1. Welsh Poppy.
2. Lady's Mantle.
3. Balsam. *Nov.* 15.
4. Ragwort.
5. Blackberry.
6. Foxglove. *Nov.* 18.
7. Self-heal.
8. Common avens.

Buttercup.
Potentilla.
Meadow sweet.
Red campion.
Wood betony.

9. Grass of Parnassus. *Nov.* 10.
10. Golden-rod.
11. Wild strawberry.
12. Barren strawberry.
13. Rue-leaved saxifrage.
14. Ivy.

Place the date when they cease flowering on the right-hand side.

Home Natural History Lessons.

Much the same plan should be pursued in teaching children of all ages, namely, that of letting them teach themselves by cultivating their powers of observation. The lesson given below, to a class of children from 5 to 9 years of age, will illustrate what I mean. Natural History lessons should always be given on specimens that the children can look at and examine for themselves. Pictures, unless specially good ones, seem to convey little or no idea of size to childish minds. I have a book on birds before me, and in the illustrations I see that the Quail is about the same size as the Pheasant, and the Tom-tit appears to be exactly the same size as the Blackbird, while the Cuckoo appears smaller than the Thrush. I also observe the

same fault in books on animals. I have thus come to the conclusion that it is better thoroughly to teach the children the life story of the animals around them, and which they see daily, than to give lessons on the Natural History of other countries, unless the neighbourhood of a museum, or the presence of a wild beast show, should afford opportunities that ought not to be neglected. You will find, in teaching Home Natural History, that the animals of other countries come in, as it were, by way of illustration; and when you see your way to making the children understand clearly something about foreign creatures or foreign plants, do not hesitate to make use of them. Though pictures, as a rule, fail to convey accurate ideas of size, there are exceptions. When you do come across an accurate picture, preserve it most carefully. A lesson once had to be given on a Wagtail. No Wagtail was at hand, but in an odd number of a science paper there was an exquisite life-sized picture of a pied Wagtail running. This was shewn to the children, who immediately said, "Why it looks as if it were going to run off the book;" and another said, "Doesn't it look as if it could wag its tail?" This is the sort of picture you should keep in sight. It conveyed true ideas

to the children, and when once a picture like this is found, it should not be lost. Keep it handy in either a pocket at the end of the Nature Note-book, or provide a small portfolio for the purpose.

You will soon see for yourself that a Natural History lesson should be well illustrated, and if, in addition to the object, the teacher has the power of reproducing things from life, with ease and facility, on blackboard or paper, the lesson will prove a complete success. There is nothing children appreciate so much as lively drawings of things they know.

All Natural History work, both in and out of doors, should be regularly done. Nothing must be taken up by fits and starts, done one day and left undone the next. You will never succeed, and the children will not get on; for if they see that it is a subject that may occasionally be put on one side, they will naturally feel that it is of no very great importance. Appoint a special time to be devoted to Natural History, and then keep to it. Definite lessons should be arranged, and given every week. The teacher should carefully prepare the lesson beforehand, getting all the illustrations together, and reading up the subject, so as to be quite prepared for any

questions the children may ask. Keep a little note-book, and enter anything that occurs to you as being a good subject for a lesson; but, at the same time, it is as well to be ready for, and to take advantage of, odd chances that may arise. If you should find a dead bat, or a mole, that you can use, give a lesson on it; and, in the same way, utilize anything else.

Another thing for you to bear in mind is that all your lessons must be arranged on well defined lines, and these must depend on season, situation, and opportunity. You will not find it advisable to start lessons on flowers in December, nor on twigs of trees in June.

Typical Lesson on the Common Snail,
Given on December 2nd, 1893.

Children's ages: Lucy, 9; Grace, 9; Connie, 8; Norman, 5. Teacher enters provided with snails (modelled in paste *), boxes of snail shells, a microscope, slides to show teeth and tongue, and several good pictures of slugs and snails.

Teacher: "Norman, have you ever seen a snail?"

N. nods head emphatically.

Teacher: "Have you all seen a snail?"

Children: "Yes, and slugs too."

Teacher: "Very well; you shall all tell me what you know about snails, and then I will tell you what I know."

* This had to be done, as live snails are very scarce, and hard to find in the winter months.

The children then tell of various "finds," and describe from memory all they know about snails.

Teacher produces a snail, and says, "What is this?" The children all laugh at the model, and seem much amused.

L.: "It is not like the shell I found; mine was yellow, with blue stripes."

Teacher produces the garden snail (*Helix hortensis*).

L.: "That is like mine."

The teacher proceeds to explain, with diagrams on the blackboard, the way in which the snail retracts its horns. She borrows a glove to show how the horns are pulled in. Discovers that they do not know where the eyes are. They talk of these, and of what use it is to the snail to have his eyes on the end of a long horn.

N.: "He could look over a wall, and see how far it was, so that he couldn't tumble."

The children all agree that it would be better not to touch the horns, for fear of hurting the eyes.

Teacher: "Norman, shew me where the snail's eyes are."

N. gently puts a very small finger on the tip of a horn, and seems to expect to see it go in.

The teacher proceeds to discuss the mouth, and shows the teeth through the microscope. The children are all amazed and delighted at the vast number, and the talk goes on about the way a snail breathes, moves &c. The teacher draws from the children the way in which the snail differs from vertebrate animals, birds and insects. The children, of their own accord, tell

that it has no bones and no blood. After the common snail (*Helix aspersa*) has been discussed, and slugs have had a passing glance, the teacher produces six common snails, the hedge snail (*Helix nemoralis*), the orchard snail (*Helix arbustorum*), &c.

The children examine the boxes of shells amid many exclamations of pleasure.

The teacher produces a large Ceylon snail, which Norman seizes promptly, insists on knowing the name of it, and the names of all the others. The children suggest names for some of the shells:—"Pinnacle shell" for *Clausilia bidens*, "Balloon shell" for *Cyclostema elegans*. The teacher asks "Why?" and the children explain. The lid of the circle shell, and the trap-door of Clausilia bidens, are next inspected; the teacher then sums up the lesson by a little talk about the use of the snail. The children seem much impressed with a few remarks about the disguise the Clausilia bidens has adopted, and, of their own accord, say, "Teacher, it's just like a beech-bud," and that a snail's work must have "something to do with his teeth."

Much fun and pleasure were exhibited by all the children, the small boy being quite equal to the older girls in grasping the main things to be observed, and afterwards took the chalk and tried to copy the diagram.

Connie, putting on her hat: "I am going home to tell my mother about that snail."

During the lesson the shells and modelled snails were freely handled by the children, many questions

were asked, and books and pictures consulted for the purpose of seeing if they were like the real things. But the shells picked up during winter afternoon walks, and the modelled snails, were the most effective things in the lesson. The teacher has since been asked several times by the children to corroborate the statements they make to the elder brothers and sisters about the snail.

Winter Work.

The twigs of trees are best studied in the winter, and, if arranged on the plan I suggested, will give plenty of work indoors; while out-of-doors the trees themselves may be looked for and talked about. Let the children find out for you how many oaks, ashes, beeches, etc., there are to be found in your neighbourhood. Snail-shells give good work for the winter, as you may find them by dozens under the hedge-rows if you will only look for them. It is quite possible to pursue these studies in both town and country; there are many trees to be found in towns, and most people have friends in the country who would send them snail-shells if they thought they were wanted. In towns it is not easy to make our boys and girls into naturalists, but there are possibilities even there. A garden in a large town in Yorkshire provided over twenty different caterpillars, many beetles, several kinds of bees, ichneumon-flies and lady-birds, larvae, moles, and a vast

army of other small creatures. Museums are generally at hand, and other opportunities for learning which are not generally found in country places.

Natural History in National Schools.

I have been chiefly speaking of Natural History work in schoolrooms at home, where the father and mother both have it in their power to help forward the work by their interest and sympathy. In ordinary schools, where the teachers are hard pressed to get through the work of preparing for the visit of the inspectors, it is not possible for them to undertake to teach Natural History in the way I have described. A great deal, however, can be done by means of well prepared object lessons, occasional walks with their teacher, and having the children a few at a time to tea; and also by setting them to work to search for things for themselves. Where there are persons at liberty to help in the Natural History in the school, a great deal may be done to supplement the teacher's work by forming a village club.

I can thoroughly recommend "Object Lessons from Nature," by Professor Miall, to school-teachers who wish to give Natural History lessons on scientific lines to large classes. Good object lessons are most interesting to children, and Natural History

taught in this way is always successful, if the teacher prepares the lessons, with plenty of illustrations and objects, beforehand It is more difficult to rouse a lively interest in nature in a school, than it is in the home circle. At first the children seem slow to understand, but, after a few good lessons, and an eager desire on the part of the teacher for "live things," the class begins to wake up, and to see what is wanted. Give lessons on common things; shew the children wasps and flies, beetles and butterflies, pointing out the wonderful part they play in the economy of nature. Give lessons on rooks and starlings, sparrows and owls, anything and everything that is familiar. Shew the wonderful disguises and mimicry around us. There will be no lack of objects as soon as the children find out what you want, for they will all be on the hunt for things for you to tell about; only do not allow anything to be brought to you "dead," and teach the children to be tender in handling and careful in carrying. Be on your guard against cruelty, especially with boys, and do not allow them to make any collections, unless done under the supervision of some responsible person; and then only when there are proper and convenient places provided for the purpose.

Village Clubs.

Village clubs are capital when they can be managed. They should be started with as few members as possible. When these are trained by holiday afternoons of field work, by many wise lessons and by careful instruction, then new members may be admitted. If too many members are admitted at first they get out of hand, and it is very difficult to keep watch over their doings; whereas, when they are trained they may be safely trusted to help to teach others. A clergyman started a small club in a village amongst the ploughboys. Once a week, during a long winter, they met in a cottage, and they become engrossed in the subject of "spiders." The success of a club will depend chiefly on the leader's own interest and enthusiasm. It is impossible to give rules that would suit every case, and the person who takes up the work will soon see what it is necessary to enforce. The chief points to be observed are the same in every case; the lessons must be regular, definite, and well illustrated. The out-door work must be systematic; field days regularly organized, and "finds" carefully looked at and explained. Club Note-books should be kept. Most of the methods I have already explained will be found to work well in either schoolroom or club. With a

"little at a time," and that little well done, you will soon make headway. The minor details must be settled by each club for itself.

Instruction may be given to the children by means of a magic lantern; essays may be written, and suitable books offered as prizes.

I strongly advise all who wish to start Village Clubs to apply to the Secretary of the "Band of Mercy," 105, Jermyn Street, London, where the necessary information for forming and working Naturalist classes can be obtained.*

To enforce the study of Natural History, without the beautiful lessons that it teaches us (to which all our teaching on this subject should tend, and to which our thoughts are naturally drawn as we learn more and more of the wonderful world in which we live), would be a serious and fatal error. It is so easy to point out the way in which each creature is so beautifully adapted for the life it is destined to lead; to point out all the wonderful means of defence, mimicry and disguises they possess to help them to preserve the precious gift of Life; from the tall giraffe—which, we are told, so exactly reproduces the light and shade, colour

* The Natural History Club of the Parents' Educational Union has endeavoured to meet the difficulty felt by amateurs in knowing how to choose and arrange Nature Lessons. Members can receive quarterly papers giving suggestions for the weekly lesson, for observations to be made out of doors, and for "handwork." Further details of the Club can be obtained at the office of the Parents' Educational Union, 28, Victoria Street, Westminster, S.W.

and markings, of its surroundings, that, from a distance, when it is feeding on the mimosa trees, even a Bushman can hardly distinguish it—to the quaint defensive attitudes, colour, and markings, adopted by some of our common caterpillars. All this affords us beautiful opportunities for teaching both spiritual and moral lessons, without objectionable preaching, which go home to the hearts of the children in such a way that the lesson once learned is never forgotten. For we must remember that children easily get hard and callous when left to themselves, taking all they see as a matter of course, and never wondering at anything. This is often the case when they are allowed to torment and murder the creatures about them for no other purpose than to add new specimens to their terrible collections.

LIST OF BOOKS USEFUL FOR STUDY & REFERENCE.

A Band of Mercy.

By FLORENCE SUCKLING.

A Band of Mercy.

"Ye, therefore, that love Mercy,
Teach your sons to love it too."
COWPER.

"ONE of the most important duties of a Mother," observes a well-known American writer (Olive Thorne Miller), "is to teach her son kindness to animals. A boy is a bundle of curiosity, and his attention is easily aroused. It is well, if the mother can spare the time, to instruct herself, and be informed of the wonderful facts of Natural History. The world is brimming with wonders, and the child is fairly hungering for information."

There are few mothers who are not acquainted, only too well, with this "child-hunger" after the hidden truths of nature, which has, from age to age, been found exceedingly difficult to satisfy. Still, the problem which is offered for solution to the matron of to-day, is as nothing compared with the perplexing one offered in the last century, when books were few, knowledge scanty, and children quite as enquiring.

Within the last twenty or thirty years a great change has come over the world of books, as well as over public opinion, with regard to matters concerning the animal kingdom; and this better state of things owes its origin, in a great measure, to what is popularly known as the "Band of Mercy Movement." Society it can hardly be called, so many and so varied are its ramifications; but its *raison d'etre* is a desire to imbue the rising generation of all classes with a tender, reverent, and intelligent love of the Creator's visible works, by means of easy lessons on Natural Science.

Nothing in Nature can possibly be "ugly," or "horrid," or "nasty," or "useless." We may say so of men's handiwork, but not of the perfect Work of God. All being deemed "good" by the Creator, neither pain, nor fear, nor death, should be meted out to them save in matters of *vital import* to the human race.

The pledge taken by members of a Band is—"We agree to be kind to all animals, and to protect them from cruelty and illusage." This pledge, it will be seen, is based upon the belief stated before—that all belong to God, and are worthy of our care.

The word "cruelty," in this case, is interpreted as "the giving of needless pain."

This little pledge, or agreement, is set forth on gaily painted cards, which, together with all the rules and regulations of the Society, with much of its literature, can be obtained at 105, Jermyn Street, London, where, also, can be had gratis a small booklet, containing all information necessary to the formation of a "Band of Mercy," and a long list of gift and lesson books published by the trade, and found suitable by competent judges.

In taking a retrospect of what is now so vast a machinery, it is difficult to point to any time or individual as its originator. Rather it would appear as if a fire were kindled simultaneously in the hearts of many people throughout divers lands about thirty years ago, all alike inspired with the desire to lead youthful minds to a better and kinder knowledge of the dumb creation. Like stars among the names of lesser note, were those of Hans Christian Andersen, in Sweden, and La Martine, in France; while in England Mrs. Gatty with her lovely "Parables of Nature," Anna Sewell and her "Black Beauty," and Mrs. Trimmer with her "Robins," amid a host of other charming writers, sowed the seeds in the hearts of those who were in those days "little folk," which is bearing in our own day such abundant fruit.

Such men as Darwin, Wood, and Kingsley did much in their day to eradicate the antipathies (tending to engender cruelty) felt towards certain animals—born of ancient superstitions—by encouraging their own children in "good-fellowship with all sorts and conditions of beasties." This new departure aptly illustrated itself when Charles Kingsley's little daughter ran to meet him (a large toad reposing comfortably in her outstretched hand) with the exclamation, "Oh, Father! do look at this dear, delightful toad!"

Henceforth certain lovers of Nature began to devote their lives to her service, in convincing the child-world that many creatures, hitherto feared and despised, could be "dear, delightful" members of out-door society.

Foremost among these unselfish pioneers was the already aged Mrs. Catherine Smithies, who, convinced of the dire need there was that someone should be up and doing, sallied forth on a wet and dreary winter's night some eighteen years ago, to gather together the children in the village schoolroom, and lay the foundation of the first "Band of Mercy," strictly so called, in the kingdom. The scheme succeeded beyond the wildest hopes of its promoters; children throughout the country flocked to the meetings,

and crowded cities followed the lead with equal alacrity. Teachers and helpers of all grades came forward, and set about instructing themselves, so as to teach others. Authors produced suitable books for prizes, and Mrs. Charles Bray gave to the movement an impetus by her inimitable "Duty to Animals," while Mr. Smithies, already Editor of the *Band of Hope Review*, started the beautifully illustrated *Band of Mercy Magazine*, the organ of the Society, with its useful monthly song, and well chosen stories, &c.

The fame of the work brought over Mr. G. T. Angell, the zealous humanitarian, of America, who saw, applauded, and returned to Boston ready to inaugurate what has since become the American Humane Education Society, including a total of twelve thousand eight hundred "Bands of Mercy," numbering, in Massachusetts alone, close upon one million members. It would be impossible to estimate the numbers throughout the whole of America; suffice it to say that some six or eight monthly journals, dealing exclusively with Natural History subjects, after the style of our own *Animal World*, are in existence; and, with the same object, Mr. Angell has, within the last year, issued one million copies of "Black Beauty" under the auspices of his Society.

"Bands of Mercy" are nowadays (as one of the children's "character songs" sets forth) "marching round the world;" for they flourish alike in Canada and Japan, in Australia and her sister colonies, to say nothing of Germany, Switzerland, and even France.

A new and very successful method of teaching the classes has of late years been adopted, and it is one which entirely does away with any excuse for object lessons which need be illustrated by living creatures under the title of "specimens"—an undesirable practice, involving too often cruelty in a greater or less degree. This mode of instruction, combined with amusement, is carried on by means of a magic lantern. The slides, mostly home made, photographs from the life or from good prints, having been sent to a "reasonable" professional colourer, are returned for amateur covering, binding and arranging as "lectures" in grooved boxes. The rest of the "plant" consists of a four-wick paraffin lantern (anything more ambitious is not only dangerous, but cumbersome for carrying), a camera stand, and a ten-foot sheet, with two rings at the top corners.

Armed with these, the teacher (usually a lady) sallies forth to the appointed rendezvous, and is joined by some other helper, who keeps

order, takes names, and, perhaps, works the lantern, or an intelligent artizan will, at a small cost, supply this need.

The quietude of the sometimes large audiences (few Bands number less than sixty members, and many possess two hundred), and the admirable essays which they send in afterwards, would surprise strangers who note the poverty of their appearance.

The Natural History Lantern penetrates into Mission Halls and into pretty drawing-rooms with equal impartiality, the slides being frequently lent by worker to worker, through the post. In this way, one town on the southern coast receives the box and type-written notes every month, from October to March, and shows them to ten Bands of Mercy within its borough in succession. Of these, one is located in the workhouse, another in a large and important ladies' school, the other eight being divided among all the church and chapel schools in the place, with the exception of one. Each secretary reads to his or her own Band, and the same artizan manipulates the lantern, till, the season being over, the slides return as they came. Essays written on these lessons obtain annual prizes, distributed at a great function at the Town Hall; they consist of books, carefully selected to bear on the subject.

It would be well for growing boys if they could pass under such tutorship as that of the Rev. J. E. C. Welldon, head master of Harrow, an ardent advocate of our cause, who is wont thus to expound its tenets to his boys. "It is for love of these dumb creatures that I plead with you. We know little of them, but we know that they are strangely like ourselves, that they have bones, and nerves, and sinews, even as we have; that they are keenly sensitive of pain, and capable of affection. Physiology, in its indisputable teaching, is ever narrowing the gulf (except, indeed, spiritually) which parts, or was deemed to part, the animal world from ours. Can you doubt that, by however mysterious means, God is accomplishing a purpose in their lives as in ours? Think of the providential power shown in making one of any of them. There may be some of you who recall how the historian Gibbon, in closing his narrative of the building of the Church of St. Sophia, at Constantinople, adds, 'Yet how dull is the edifice, how insignificant is the labour, if it be compared with the formation of the vilest insect which crawls over the surface of the Temple.' These are the creatures so mysterious, so full of marvel, of which, as I have said, you are the masters. Do not be ignorant or careless of the duty

you owe them. Remember, even in your daily life, what you may become to them, they to you. The world is full of mysteries, and every mystery is a great possibility. But if I would have you learn the lesson of God's care for animals, and all that flows from it, it is that you may not think of them merely to be killed and conquered, but as mysterious beings for which you are responsible to Him. For I think that Paradise was lost on the day when beasts became afraid of human presences. And I fondly hope that it will be won on the day when, if I may use of each of us the prophetic language of an ancient writer, 'Thou shalt be in league with the stones of the field, and the beasts of the field shall be at peace with thee.'"

"Train yourselves," says Canon Farrar to all friends of humanity, "train your little children, train your young boys in acts of mercy and kindness to animals, for mercy and kindness are diffusive, and the child who has learnt tenderness to the brute creation is far more likely to learn the lesson, 'Be ye kind one to another.'"

"Every leader of thought," says the talented author of 'Workers without Wage'—"and who is not one, more or less?—should remember that he becomes in a measure responsible for the remote results of his precept and example.

So it is with a trifling act or thought or word, especially where the young are concerned. It is to the innocent prattlers of to-day—the parents of the future—that we must trust for the dawn of a better era, and these may now be moulded as wax."

Longfellow says to those who are parents :—

"How shall I teach your children gentleness,
And mercy to the weak, and reverence?
For life, which in its weakness or excess,
Is still a gleam of God's omnipotence;
Or death, which, seeming darkness, is no less
The self-same light, although averted hence,
When by your laws, your actions and your speech,
You contradict the very things I teach?"

The literature of to-day teems with beautiful lessons of the animal world; we have nothing to do but to invite the little ones to turn to Nature for their happiest inspirations.

"And Nature, the old Nurse, took
The child upon her knee,
Saying, 'Here is a story book
Thy Father has written for thee.'"

"Come wander with me," she said,
"Into regions yet untrod,
And read what is yet unread
Of the manuscripts of God."

APPENDIX.

THE Editor has obtained permission to insert the three following chapters, as she believes that the practical suggestions they contain will prove of great value in helping lovers of nature to be systematic in their own studies and in the lessons they may give to children in Natural History.

I.

Home Museums.

Reprinted, by permission of Mr. T. Fisher Unwin, from "More About Wild Nature," by Mrs. Brightwen

Home Museums.

GENUINE students and lovers of nature—indeed, any of us who find it a duty as well as a pleasure to learn as much as possible of its mystery and beauty—will never be satisfied with mere book knowledge of the wonderful world in which we have been placed. The dweller in the country lives all day in a vast storehouse, which we roughly divide into animal, vegetable, and mineral kingdoms, each in its natural relation to the others, each helping in the formation and support of the others. There is never any possibility that a dried and stuffed and ticketed collection, no matter how extensive, can give us teaching like this.

For those who cannot study nature "at home" in the country, there are now extensive and well-arranged collections accessible to all. The grand Natural History Museum at South Kensington, the splendid Museums of Botany at Kew, and the great collection of minerals in the School of Mines in Jermyn Street—these, or any of these, will give opportunities for months of study, with increased pleasure and knowledge every day. But, however much we may use our opportunities of study, either in the fields, woods, or in the great national collections, most nature students will like to have some private collection of their own, to which they may turn in leisure moments, or which

they may re-arrange on a rainy afternoon. Almost every article in such a collection will have for them some private association—the mode in which they acquired it, the locality in which it was found, the friends, perhaps no longer here, who shared their delight in securing the prize.

I can speak from practical experience of the great pleasure of possessing a home museum, and, believing that others may welcome a little information on the subject, I will try and give some simple suggestions which will enable those who are anxious to do so, to make collections of their own ; it is an easier and more inexpensive matter than might be supposed, and I can truly say it affords a life-long source of interest.

My little museum had, like many other things, a very small beginning. As there was plenty of space on the walls of the billiard-room, I had a case made to contain specimens of nuts and seeds which had been stored up in various cupboards and boxes about the house. These objects, neatly arranged and named, were hung up in a wall case, and formed the nucleus of the future collection.

As I have taken an interest from my earliest years in all kinds of foreign seeds, such as those of palm-trees, tropical plants, fruits, &c., friends were often kind enough to give me any they had obtained in their travels abroad. Some I met with in various shops ; and thus in time I had sufficient to fill one side of a wall-case, measuring four feet by two feet, with a glass front. In the opposite side of the case I thought it would be interesting to arrange specimens of

many kinds of drugs used in making ordinary medicines. I, therefore, obtained from chemists such articles as castor-oil seeds, a piece of Turkey rhubarb, specimens of different barks from which quinine and other tonics are made, colocynth gourd, aloes, manna, and a great number of gums and other substances which are required in the healing art, not forgetting a few blister beetles and cochineal insects.

The case was lined with white paper, and divided into columns by thin strips of beading, nailed down with small brads. These columns were again divided horizontally by beading, thus leaving little spaces three inches by two, in each of which a specimen was placed, with its name and special use affixed. It was a great interest to me to read about all these medical drugs, to learn where they were obtained, and how prepared and used, and many a happy hour has been spent in explaining about them to the hundreds of poor people who come from dreary homes in London to spend long summer days in my place. My own visitors, too, often plead for a chat in the museum when kept indoors by wet weather.

I may create a smile when I speak of my "scullery" as being the next object of interest we come to in the museum; but what else can I call a collection of more than a hundred skulls? They are mostly those of birds, ranging from the eagle to the wren, and from the swan to the stormy petrel.

When one speaks of the study of anatomy, the word seems to suggest something that can only belong to medical student life—something

quite beyond the reach of young people, and possibly not desirable even if it could be attained. I think there is, however, a word to be said for the intelligent study of bone structure, which, from my early childhood, has always possessed a singular fascination for me. The skull of a bird neatly prepared, white as ivory, perfect and beautiful in its adaptation to the conditions of the bird's life; a portion of the spine of a fish, cleaned and dried before the fire, showing the many joints which make it flexible, the hollow for the spinal marrow, and the bones to protect it from injury; the foot of a mole, with its intricate structure; these and endless other quite simple preparations would afford young people hours of delightful study. The bones, once prepared, can be labelled with English and Latin names, and kept in the home museum ready to be shewn to young friends, or made the foundation of elementary lectures to country lads and parties of poor people. It has sometimes been my pleasant occupation, during long winter evenings, to meet about twenty or thirty boys at our village-room, and, taking my collection of prepared animal and bird skulls, I try to explain, in very simple language, the various interesting things that can be learnt from them. The boys give very close attention, and look with such eagerness at each little bone as I hold it up and talk about it, that I long to give them each a specimen to take home, as a reward for their goodness in sitting quietly as long as I am able to stay to talk to them.

The only articles required for preparing

skeletons are these: a small saucepan, a penknife, a carpet-pin, and a nail brush. Suppose we ask for the head of a duck from the larder, either with feathers on or without will not matter We place it in the saucepan filled with hot water, and let it boil gently about twenty minutes. By that time it should be possible to take off all the flesh, and, by rinsing the head and carefully using the brush, at length we obtain a clean skull, which will only need to be dried before the fire or in the sun until whitened, and then it will be ready for the museum shelves. The brain is easily got rid of by inserting the head of the pin through the orifice at the back of the skull, and working it about, until, by constant rinsing, the head is emptied. The lower half of the beak should be cleaned separately, and, when dry, a small indiarubber band will keep it in its place. A label with English and Latin name should be attached at once, else after a time one may not be able to tell the exact species when numerous skulls are arranged side by side.

The length of time a head must be boiled must vary much, according to the size of the specimen, and this can only be learned by experience. A robin or a mouse's head only needs about ten minutes, and if overdone will fall to pieces. Some animal skulls are extremely difficult to prepare; the mole, for instance, requires very delicate handling, else the fragile cranium comes to pieces; yet it is well worth taking the trouble to obtain a perfect specimen, for the jaws are furnished with such formidable rows of teeth that they suggest those of a

miniature crocodile, and one can well understand from them the mole's power of crunching worms and fighting with its own species. It is very instructive to place on the same card the upper and lower jaws of a shrew and a house mouse. One can then see how they differ, the former being insectivorous and flesh-eating, and the latter, belonging to the rodentia, able, with its powerful front teeth, to gnaw through wooden planks and find its way into store-closets, as the housekeeper often finds to her cost.

Another interesting preparation is a bullock's foot. We should order from the butcher what is called an ox-heel, and ask the cook to boil it as she would to make a shape of calf's-foot jelly. When this is done the heel will be still intact, and we can begin to take it to pieces; and as each bone is cleaned it must be placed on a large sheet of paper, and one after another each one must be replaced next to its fellow, and never moved again until dry and white. Then, having a piece of cardboard large enough to take in the whole foot when placed lengthwise, we may begin with a needle and stout thread to tack down each bone in its place, till the whole is completed. When I am showing my museum to a group of poor people, I always draw their attention to the bullock's foot, and enjoy their amazement at the way in which the bones fit in, the velvet softness of the joint surfaces, and the sculptured beauty of the shank bone.

Subjects for anatomy are very easily obtained; the turkey at Christmas, the goose at Michael-

mas, the game birds in constant use, the rabbit and hare, all afford interesting skulls, and their feet are also worth retaining, since, if nailed to a board and dried before the fire, they will, when named and arranged, add interesting items to the museum walls.

In the heads of cod, haddock, whiting (and possibly many other fishes), two small snowy-white bones are to be found, one in either half of the skull. They are supposed to assist the power of hearing, and are called otoliths or ear-bones. The skull must be broken carefully to pieces to find them; they lie in the two cavities in the back part of the head, and resemble very small white almonds.

These bones are well worth preserving for several reasons. Those of each individual species, neatly mounted on a card, form an interesting museum specimen, as they vary in shape and size in different fishes, and are unlike any other bones I am acquainted with.

Then they also have an artistic use. I collected these otoliths for several years till I had a sufficient quantity, and then they helped to make a very original banner-screen. If five of them are placed starwise they form a perfect jasmine flower, and sprays of green beetle's wings on a ground of rich dark coloured satin or velvet, with these jasmine flowers introduced, have a charming effect. Each otolith and beetle-wing must first be neatly tacked in its place with fine white and green silk, and then gold braid sewn round each so as to hold them firmly in place, the braid thus forming the stems of the sprays. A few delicately

embroidered butterflies, studied from nature, will add colour enough to make a very agreeable work of art.

Beautiful white bones are to be found in the brown outside skin of a large turbot, and these also would be worth preserving to be used in needlework. They are like tiny morsels of hoar-frost, white and delicate; they only need to be soaked in hot water to get rid of the gelatinous skin in which they have been embedded, and this is easily cleaned away with a nail brush. Two stitches with fine white silk will affix them to any textile material, and, in combination with embroidery and gold thread, very pretty effects may be obtained.

I once picked up a dead swallow, and, with great care, it was at last prepared whole, and fastened to a card. A truly wonderful little skeleton it proved to be, so fragile and delicate that a careless touch would crush it in a moment, and yet, when alive, the possessor of that tiny frame could wing its way, mile after mile, across the sea, seeking, by unerring instinct, some warmer land in which to pass the winter.

Thus gaining insight into the formation of the wonderful creature we call a bird, which, in all its parts, is a miracle of contrivance and adaptation to special ends, must surely increase our love and reverence, not only for birds, but, indeed, for all living things, since, in whatever direction we may pursue our studies, we are met with such evidences of divine wisdom and skill that a thoughtful mind is filled with wonder and praise. I must always maintain, that

leading the young to investigate these things for themselves in a reverent spirit, cannot fail to minister greatly to their present pleasure and eventual mental profit.

The facial line in birds is most interesting. I am not learned on the subject, but, following Camper's ideas, I find that it *is* usually those birds with an upright skull that possess the most intelligence. A line drawn from the tip of the beak of a blue-tit to the apex of the skull will shew a far higher angle than the same test applied to the head of a willow wren or tree creeper, and, charming as the two latter birds are, they have not a quarter of the "nous" of the clever little tit. The possession of a collection of skulls opens the way to many an interesting line of study in connection with the living birds and their ways as seen in our gardens and fields.

The study of bone structure tends to cultivate many useful qualities. Neat handedness is very essential, for one clumsy touch may simply mar an hour's careful work.

Patience will also be developed, as I can testify; I once placed some small skulls in a pan of water in the garden, in order that they might skeletonise by soaking. They were nearly ready to be washed and cleaned, when a family of enterprising ducks found out the pan, and reduced my skulls to a delicate mince. Occasionally I have over-boiled some rare head, and then I knew that, having spoiled this one, I might have to wait for months or years before I could obtain another.

All these disappointments are teachings, and

a true naturalist is never discouraged. "Everything comes to him who knows how to wait" is an extremely true saying. I know hardly any better corrective for the impatience of youth than the steady plodding work involved in carrying out any of the branches of the study I am endeavouring to bring to the notice of my readers.

Before speaking of the cases of minerals in my museum, I will try to explain how easily such objects may be kept and shewn without having expensive cabinets to contain them, which is often a difficulty in the path of young mineralogists. Supposing there is but limited space, small shelves, three inches wide, and three or four inches apart, can be made of plain deal, stained brown, and fixed against the wall, with glass doors to keep out dust. Any carpenter can carry out this plan at very little cost. An immense number of specimens can thus be arranged, and are much more readily seen in this way than in the drawers of a cabinet.

There is, to my thinking, an unfailing interest about stones of all sorts and kinds. They reveal so much about the history of our country, and tell us in a mute sort of way that they are the remains of long past ages, and have survived all kinds of upheavals, glacial periods, and changes of temperature. Wherever one may happen to be, something can be picked up in the way of minerals for the shelves of the home museum, and those fossils or stones which we have ourselves discovered will always be reckoned far more valuable than any bought

specimens. On this north side of London, where we live on very high ground, which was once covered by the sea, the pebbles are all rounded by attrition, and many are brittle and full of cracks from their great age; some polish well, and show beautiful colours and veinings; others contain impressions of fossil shells and sponges. The ventriculites, it is true, are generally broken in the middle; indeed, it is rare to find any perfect fossils, but even the pieces are worth preserving, as they can be compared with the perfect forms figured in geological books. The flints, with cavities filled with quartz crystals, are of many forms, and sparkle brightly. Chalcedony and jasper can be picked up in our roads. Large masses of pudding stone occur in the fields, and when cut in half they take a high polish. A large artificial cave in the grounds here is mainly formed of blocks of this stone. Now, our neighbourhood is not, by any means, rich in minerals, but I instance the foregoing to prove that, even here, stores for the home museum may be found and utilized. No doubt in other places a far greater variety could be obtained.

Most people have several "outings" in the course of the year, when, usually, there would be opportunities for collecting many kinds of specimens—fossils from the chalk or the lias, granites from Cornwall or Scotland, ores from any of the mining districts, pebbles from the sea-coast; all these and many more can be obtained in our own country, and, of course, a foreign trip would afford a much wider range of possibilities for acquiring geological specimens.

The classifying and arranging the minerals thus obtained in various ways, forms a delightful occupation for intelligent young people when kept indoors during the holidays by wet weather, and it is pleasant to watch the keen interest with which fresh specimens are welcomed and talked over, each one having, perhaps, its own personal history. This is the case with my own mineral possessions; one stone was picked up in the bed of an Alpine stream, and always recalls to me the beauties of scenery, the purity of air, and the sweet scents I enjoyed during that mountain ramble. The limestone fossils speak to me of picturesque Derbyshire, with its wonderful caverns, stalactites, and crystals. Jaspers of every shade made up the beach at Aberystwith, and a glance at the polished specimens I brought home with me from that shore never fails to bring back to my memory the soft blue distances of the Welsh hills and the grand masses of the old Silurian rocks. My knowledge of geology being but very elementary, I had often found it difficult to ascertain the names of my specimens, even with the aid of books. I was, therefore, glad to discover that any professional mineralogist will correctly name one's treasures for the small sum of one penny each. When this is done, the classifying becomes comparatively easy. If one watches for opportunities, small pieces of minerals, never likely to be found by oneself, are easily obtained by enquiring for a working lapidary's shop. It will probably be found in a back street, kept, often, by a poor working man, who will be glad enough to

obtain and cut small specimens of whatever we are seeking. As a rule, it is best to avoid the showy lapidary shops at the seaside, as they are apt, as a rule, to be high-priced and unsatisfactory.

I find the inner tray of ordinary matchboxes a very convenient receptacle in which to place small stones or crystals. The trays being all of one size and shape, they fit in rows and take up little space; when re-papered, with some white cotton wool at the bottom, they look neatand keep the minerals from getting mixed.

Models of foreign fruits occupy the next wall case, and with them are some huge pods of tropical plants, such as the Entada, or sword bean of the East and West Indies. This is said to attain a length of from six to eight feet, and its seeds are converted by the natives into snuff-boxes, scent-bottles, spoons, &c. I have a *coco de mer*, or double cocoa-nut, the fruit of a tree which is only found growing on two islands of the Seychelles group, and in which the late General Gordon took a special interest. He greatly lamented that this magnificent palm is gradually being eradicated by the constant felling of the trees to obtain the nuts, and urged that steps should be taken, before it is too late, to hinder the thoughtless destruction of such a rare and noble tree. The palm itself takes a century to come to maturity, and the nut, although it attains its full size in four years, requires ten years to be fully perfected, when it weighs about forty pounds.

The other specimens in the case are a dried baobab fruit; a pod twenty-six inches in length,

containing the seeds of some unknown plant; models of the banana and breadfruit; a piece of the stem of some ivy, grown here, which measures eighteen inches in circumference; and a portion of ancient papyrus on cardboard. I may here mention that anyone who happens to have papyrus growing in a greenhouse tank, can very easily make paper from it if so disposed. I have succeeded in making some which exactly resembles that used by the Egyptians. If the stem is cut into six-inch lengths, the green bark sliced off, and the rest cut with a sharp razor into thin layers and placed on clean white paper, a row of the slices touching each other, continued to whatever length is desired, then another row placed over these transversely, leaving no gaps, and the whole pressed quickly between sheets of white glazed paper, it becomes a mass of thin pulp. The glutinous juice of the plant makes the separate pieces adhere, and, if carefully lifted to fresh paper and well-ironed until dry, the manufacture will be a success. If the pulp, covered by the paper above and below, is placed between two sheets of millboard, one can then stand upon it, and ensure its being well-pressed. It can be written upon with an ordinary pen, without sizing or any further preparation.

With regard to fruits, I may mention that many curious specimens may be obtained by asking a fruiterer, when purchasing at some of the importers' warehouses, to reserve such things as the Brazil-nut as it is gathered, *i.e.*, a large woody fruit, containing from eighteen to twenty-four of the triangular nuts. Most

people express surprise when told that the nuts grow in this kind of wooden box, as they are seldom sold in the outer case. The cocoa bean grows in a similar manner, in a long, hard-shelled pod. It is possible in this way, also, to obtain from the importers of foreign fruit, a cocoa-nut with its outer case on, beginning to grow, and sending out a green shoot. If the nut is planted in a large pot, and kept in heat, one may see the very interesting growth of a baby cocoa-palm, so beautifully described by Kingsley in his book, "At last." Among the things sold by Whiteley are long stems of sugar-canes newly imported. These are worth possessing, as showing the structure of grass on a large scale, but I would add a word of caution about handling the leaves. They are covered with minute spicules, which, entering the pores of the skin, are apt to cause great pain and discomfort.

I think I have said enough to show how, in various ways, one may keep enriching one's collection. A visit to a new place always suggests, to my mind, fresh chances of meeting with curios, and thus the possession of a home museum gives a pleasant interest to our walks, whether they are in town or country.

II.

Object Lesson Cases for the Schoolroom.

Reprinted by Permission of the Society for the Promotion of Christian Knowledge, from "Home Work for Willing Hearts," by Mrs. Brightwen.

Object Lesson Cases for the Schoolroom.

THESE cases are greatly desired by the masters and mistresses of schools where object lessons are given.

Imagine an object lesson upon leather and its uses, without a specimen to show; a large class of boys in all degrees of weariness and fidget; the master vainly endeavouring to keep their attention while he speaks of skins being tanned and prepared, and the various kinds of leather made from different animals. He may do his best, but, after all, he can but give a certain number of facts, which only the more intelligent boys will be able to grasp, and the rest will have but vague ideas of the subject, because the eye has not been called into the service of memory to deepen the impression. Now, if the master held in his hand a piece of sheep's skin, with the wool on, and spoke of the processes needed to clear off the wool, and followed the course adopted by the tanner to turn the skin into leather, and could then show pieces of horse-hide, used to make harness—ass and goat hide, made into vellum—fine kid skin used for gloves, and so on, through all the various adaptations of skins, the children's attention would be gained; they would remember what they had *seen*, and the object lesson would be one of the most enjoyable times in their weekly course.

I have taken great interest in the formation of these cases, having made one for each of our national schools, and set a great many friends to work to make others for their own village schools. The case may be made of any size, but the following dimensions are usually found suitable :—

Length, 43 inches ; height, 32 inches ; inside width, $4\frac{1}{2}$ inches ; outside width, $6\frac{1}{8}$ inches. Two glass doors with lock and key ; panes of glass, $28\frac{1}{2}$ inches by $18\frac{1}{4}$ inches. The wood may be $\frac{3}{4}$ inch deal, stained brown.* The inside should be neatly lined with white or tinted paper, and as the objects are prepared, small tacks may be placed on which they can be hung. As the objects vary much in size and shape, it does not answer to put the hooks or tacks in beforehand, as room would probably be lost by things not fitting into regular spaces.

A list of some of the various things required to fill the case is given at the end of this chapter, and of course it may be varied according to the possibilities of obtaining suitable specimens. In the country, it is quite an added pleasure to one's daily walks to bear in mind that a fir-cone, a piece of flint, a few pieces of wood, or bark, of different kinds, a fragment of slate, glass, or china, all are needed, and tend to complete the collection.

Where there are young boys in a family, home for the holidays, full of life, and longing for something to do, the idea of collecting for the school

* The cost of such a case is about £1 10s. It will contain about one hundred and fifty specimens.

case is hailed with delight as a new source of interest. On first glancing at the list of things required, it may seem difficult to attempt to procure them; but I will show how, at a very small expense, the greater part of them may be obtained. The metals need only be small pieces $2\frac{1}{2}$ inches long, and one inch wide; and any tinman would cut them out of waste pieces, and be glad to sell them for a penny each.

The stones can generally be picked up; if not at home, they would be found at the seaside, or wherever we may go on a visit. Where a new house is building, several kinds of stone may be generally found, and the builder will almost always give a few specimens to young people if told of the purpose for which they are wanted.

Hearthstone and Bath brick are in use in most kitchens, also charcoal, possibly anthracite and coke. At a chemist's one can get a poppy-head for a penny, a piece of roll brimstone, the different gums, the blister beetles or cantharides, and possibly many other useful specimens.

On the sea-beach at Brighton, I have often found a basketful of small objects suitable for the school case. Cabbage-stalks become skeletonized and bleached white by the action of the sea, and show the woody fibre of which they are composed, and from which a teacher can explain the growth of trees, and the arrangement of leaves upon their branches. Pieces of rope, too, are to be found with their ends unravelled into the hemp threads of which the rope is composed, and such a specimen, compared with a new rope, would shew the children how the plant-stem at last becomes a cable. Dried star-fish, various

kinds of shells, the egg-purses of skate and dog-fish, sponges of different species, corallines, &c., are simple homely things, it is true, but entirely out of the reach of hundreds of school-teachers, and, therefore, to them of great value. At other places iron pyrites, cuttle-fish bone and fossils may be found on the shore, and when travelling anywhere an observant eye will be quick to observe by the roadside much that may be turned to good account.

Each specimen needs to be hung up in the case, and some ingenuity is required to contrive that each shall have a loop of some kind to hang it by. The metals, woods, and many other things will allow a small hole being drilled at one end, through which a piece of wire can be put and then twisted into a loop. Stones, nuts, etc., must have the wire placed firmly round them. Card suspenders are useful in some cases, and are easily attached. Copper or brass wire can be bought in hanks at the ironmonger's, a pair of pliers for about one shilling, and an Archimedean drill at one shilling and sixpence, will be all that is required to prepare the specimens for arrangement in the school case.

List of desirable Articles for School Cases.

METALS.

Iron—Wrought and Cast.
Copper—Copper Wire.
Brass—Brass Wire.
Lead.
Tin—Bar Tin.
Solder.
Iron Pyrites.
Zinc.
Any Metallic Ores.

STONES.

Granite.	Asbestos.
Flint.	Mica.
Chalk.	Rounded Pebble.
Bath and Portland Stone.	Tile.
Slate.	Limestone.
Bath Brick.	Brick.
Sand Stone.	Quartz—Glass.
Pumice Stone.	Jasper.

FOSSILS.

GUMS.

Tragacanth, Arabic, and any others that can be obtained.

EGGS.

Hen.	Duck.
Turkey.	Goose.

To be carefully blown, and hung up by a wire run through the egg.

NUTS.

Cocoa-Nut of small size. The inside removed by a hole cut at one end.	Brazil Nuts in their case, if obtainable.
Pea-Nuts.	Nutmeg with Mace round it.
	Butter-Nut.

A BUNCH OF DIFFERENT KINDS OF LEATHER TIED TOGETHER.

Horse-hide.	Russia Leather.
Ox-hide.	Roan.
Sheepskin with wool on.	Kid.
„ tanned.	Ass-skin and Vellum.
Basil Leather.	Pigskin.

WOODS.

Deal.
Oak.
Beech.
Mahogany.
Ebony.
Cedar.
Boxwood.
Cane.

MISCELLANEOUS.

Sealing Wax.
Piece of Brimstone.
Sponge.
Coral.
Cork.
Poppy Head.
Glue. Rosin.
Gutta-percha.
India-rubber.
Cotton Pod and Yarn.
Flax Fibre.
Carob Pod.
Horsehair.
Bristles.
Teazel Head.
Honeycomb fixed in small box.
Charcoal.
Anthracite Coal.
Tobacco Leaves, and some in rolled pieces.
Oil Cake.
Cotton Cake.
Outside of Pomegranate dried.
Cedar Cone.
Spruce Fir Cone.
Carpet of different kinds.
Cabbage Stalk skeletonized to show woody fibre.
A Piece of New Rope.
Horse's Hoof.
Bullock's Hoof
Goose Foot dried.
A Case with Drawing of Silkworm, the eggs, moth, cocoon and silk wound.
Cuttle-fish Bone.
Ivory.
Bone.
Skeletons of Heads of Fowl, Pheasant, Cat, Rat, Stoat, and any others obtainable.
Star-fish dried.
Mussel Shell.
Oyster.
Whelk.
Limpet.
Different kinds of Corn in the ear.
Piece of China.
„ Earthenware.
„ Tile.
„ Coke.
Cantharides gummed on to a card.
Egg-purse of Skate.
„ Dog-fish.

SPECIMENS OF GRAIN.

Barley.
Wheat.
Oats.
Rye.
Hemp Seed.
Indian Corn.
Flax.
Lentils.
Beans—Broad.
Beans—Horse.
„ Haricot.
Peas—Whole and Split.
Coffee—Unroasted.
Tea.
Millet.
Canary Seed.
Sunflower Seeds.
Tares.

The grains mentioned above should be placed in little brown holland bags, three inches long by two inches wide, with a curtain ring placed round the top, in the hem, to keep the bag open, and a small ring sewn on one side to hang it up by. These bags can be placed on small hooks down each side of the case. The $4\frac{1}{2}$ inches width will allow about 28 of them to hang on each side.

III.

Portions of an Almanack,

Compiled by a girl of 15 from personal observation.

[NOTE.—*The Almanack from which the following extracts are taken was awarded the prize offered by the Publishers of the "Child Life Almanack" for the most complete set of phenological notes, prepared from actual observation, confirming or supplementing those given in the Almanack.*]

Portions of an Almanack,

Compiled by a girl of 15 from personal observation.

[The following abbreviations have been made use of: fl. for flowers; ap. for appears.]

MARCH.

1 Currants and Gooseberries in leaf.
2 Bluebell buds above ground. Daffodil buds unfold.
3 Gloryless fl. Dog's Mercury fl.
4
5 Coltsfoot fl.
6 Shepherd's Purse, wild Anemone, Kingcup and Cuckoo Flower fl. Capsules of Cushion or Screw Moss ripen.
7 Daffodil fl.
8 Palm anthers burst. White Butterfly ap. Peach blossom nearly out.
9
10 March dust flying—watercart in use. Elm fl. Bullfinches pair.
11 Forget-me-not fl.
12 Wild white Violets fl. Larch, Box, Butter-burr fl. Larch leaf. Saw frog's spawn in stagnant pond and running water. Sulphur Butterfly ap. Bumble Bees ap. Song Thrushes build.
13 Purple Alison fl.
14
15
16 Pear fl.
17
18
19 Ants ap. Red Currant, Hyacinth, Blue Plum fl. Spindlewood in leaf.
20 Ribes fl.

21 Tulips, Gooseberry, Dog-toothed Violets, Chymondoxa, Primular Rosa, common Dog Violets fl. Cottonwood leaf.
22 Saw Gerris.
23 Bat ap. Mare's Tail leaf.
24 Hazel leaf. Raspberry leaf.
25 Cherry, Ash, Pirus Japonica, Blackthorn, Stitchwort, Ground Ivy fl.
26 Mare's Tails, Cow Parsley, Greengage, Cowslip fl. Peach and Apricot leaf. Hornbeam catkins out. Lilac flower buds ap.
27 Raspberry leaf.
28 Golden Saxifrage fl. Saw Snake lying out.
29 Plum leaf. Wood-sorrel fl. Asparagus above ground.
30 Black Currant fl.
31 Barberry fl. Apple fl.

JULY.

1 Ragwort fl. Musk Mallow fl. Wood Sage fl.
2 Garden Mint fl.
3
4 Burdock fl.
5 Rest Harrow fl. in meadow.
6 Wasps have nests.
7
8
9 Yarrow fl.
10
11 Oats are cut. Wild Forget-me-nots fl.
12 Succory fl.
13 Mountain Ash berries are ripe.
14 Great Willow herb, Corn Sow thistle, Fleabane, Great Purple Loose-strife, Hemp Agrimony fl. Wood briony berries ripen. Hop fl.
15 Saw flock of Long-tailed Tits. Apples are ripe.
16 Song Thrushes still sing.

17 Heard Robin sing. Pink Persicaria fl. Wild Canterbury fl.
18 Saw White Plume moth.
19
20 Cuckoo-pint berries are ripe. Cottonwood berries are ripe. Spear Plume Thistle fl
21 Wild Harebell fl.
22 Found nest of Whitethroats, fledged.
23 Fairy Mint fl. Barley is cut.
24 Teasel fl. Peppermint fl.
25 Great napweed fl. Anemone Japonica fl.
26 Plums are ripe. Thrushes have ceased to sing.
27 Wheat is cut. Pears ripen.
28
29
30 Hawthorn berries are ripe.
31

DECEMBER.

1 Starlings resort to buildings this month.
2
3
4
5
6
7
8
9 Laurestinus fl.
10
11
12
13 Christmas Roses are out.
14
15
16
17 Saw a great many young lambs, about 2 weeks old. Oaks bare.
18

19
20 Larks flock. Wood-cutting has commenced.
21 Found Red Cup moss. Anthers of hazel catkins burst. Gnats dance.
22 Ivy berries ripen.
23 Elder leaf.
24 Honeysuckle in leaf.
25
26 Went for walk and found the following :—Speedwell, Shepherd's Purse, Chickweed, Palm (anthers burst), Primrose, Dandelion, Groundsel, Red dead Nettle, Daisy, Buttercup, Gorse.
27 Heard Robin, Song-thrush, and Hedge Accentor sing.
28 Heard Wren sing. Chaffinches flock. Went for walk and saw :—1, Sparrow; 2, Hedge Accentor; 3, Fieldfare; 4, Pigeon; 5, Goldcrest; 6, Wren; 7, Thrush; 8, Robin; 9, Chaffinch; 10, Pheasant; 11, Rook; 12, Blackbird; 13, Jay; 14, Water Rail; 15, Coal Tit; 16, Great Tit; 17, Wild Duck; 18, Snipe; 19, Heron; 20, Starling; 21, Jackdaw; 22, Moorhen; 23, Yellow hammer; 24, Bullfinch; 25, Wagtail; 26, Partridge. Chaffinches flock. White dead Nettle fl.
22 Lesser Celandine fl. Found a Scabio blossom.
30
31 Saw small flock of Goldfinches. Thrushes collect in flocks.

32, FLEET STREET,

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